The Petroleum Engineer

ALL DIVISIONS

• Exploration Drilling and Production
• Refining and Gas Processing
• Oil and Gas Pipelining

APRIL, 1950 • VOLUME XXII • NUMBER 4

GENERAL

Exploration Costs Six Times Pre-War A-33
H. J. Struth

Possibilities for Production of Liquid Fuels From Shale, Natural Gas, and Coal—Part 2 ..... A-45
Paul D. Torrey

Features

Course of Oil ..... A- 4
Highlights in Oildom ..... A- 8
Scanning Washington's Oil Horizon A-10
National Petroleum Situation A-12
Petrolic Personalities A-14
Dick Sneddon
Meetings A-18
Letters to the Editors A-22
Petroleum Profile—Ralph K. Paine A-52
General News ..... E- 1
General Personals ..... E- 9
Laugh With Barney E-12
The Petroleum Engineer's Continuous Tables (Installment No. 154—Bibliography) E-17
Oil and Gas Trade News E-22
Trade Personals E-27
New and Improved Machinery and Equipment E-33
Trade Literature E-39
Book Reviews E-42

EXPLORATION, DRILLING AND PRODUCTION

Deep Drilling Last Year Cost $100,000,000 ..... B- 7
Ernestine Adams
Exploratory Drilling in 1949 ..... B-40
Frederic H. Lahee
Evaluating Native Clays for Use as Drilling Muds B-50
V. B. Zacher
Preliminary Report on Oil Recovery by High Pressure Gas Injection B-54
L. P. Whorton and W. F. Kieschnick, Jr.
A Rapid Method for Permeability Calculations B-72
A. S. McLatchie
Drilling Barge Designed for 20,000-Ft Depths B-79
25,000th Radioactivity Log Run—Famous Well Gets Honor B-80

Features

Editorial—Expanding Petroleum Frontiers ..... B- 3
Production News B-86
What's Doing in Drilling B-90
Exploration Activities B-94
Running Tour With Men in the Industry B-98

REFINING AND NATURAL GAS PROCESSING

New and Old Units of Fawley Plant ..... C- 5
V. S. Swaminathan
Platforming ..... C- 9
Vladimir Haensel
Water-Cooling Towers—Part 2, *Types and Construction* C-15
Howard E. Degler
How to Estimate Plant Construction Costs—Part 2, *The Preliminary Estimate* C-21
George E. Brooks
The Technical Forum—Questions from Our Readers Answered by Panel of Authorities C-28
Radioisotopes Aid Corrosion Research C-31
Jack M. Swartout

Features

The Turnaround ..... C- 3
Jet Fuels From Shale Oil
Anti-Knock 'Antagonists' Taboo
Fundamental Research Lags; National Defense May Suffer
News C-34
Refining and Gas Processing Personals C-40

OIL AND GAS PIPELINING

Western "Super-Inch" Gas Line Off to Good Start ..... D- 7
Staff Members of Pacific Gas and Electric Company and Bechtel-Price-Conyes
Microwave Radio Relay System D-11
J. D. Munton
Odorizing Natural Gas D-18
Robert M. Hutchison
Mid-Valley Pipeline System D-22
Frank H. Love
Remote Control Fire Valves D-26
W. J. Quinlan

Features

The Firing Line— ..... D- 3
Extent of FPC's Jurisdiction
Transportation News D-30
Transportation Personals D-33
With the Pipe Line Contractors D-34
Pipe Line Projects D-36
Pictorial D-40

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Exploratory Drilling Costs

Domestic oil reserves on January 1, 1950, were the highest in history. Including all crude oil and natural gas liquids, they totaled 28,442,000,000[1] barrels. The new oil reserves discovered during 1949 totaled 2,798,000,000 barrels. Of this volume, 1,815,000,000 barrels were discovered by extensions to previous discoveries (secondary exploration); the remaining 983,000,000 barrels were wildcat discoveries that opened new fields (initial exploration). In other words, secondary exploration (extensions to existing fields) accounted for two-thirds and initial explorations (wildcat drilling) one-third of the new oil reserves discovered during 1949.

New domestic oil reserves discovered last year by initial exploratory drilling was the greatest in 15 years. The total number of exploratory holes drilled was 14,025, the greatest number of such holes drilled in any one year in the industry's history. This number includes all initial and secondary exploratory wells and dry holes.

On a per well basis, secondary exploration wells discovered ten times as much new oil as initial exploratory wells. The amount of oil discovered today by initial exploratory wells is much less than in former years. In 1945, 3.1 wells were drilled per million barrels of oil discovered; in 1949, 4.6 wells were necessary to discover the same volume of oil.

Exploration costs in 1949 were six times those in the years 1935 to 1939. It is a significant fact that annual exploration costs based on a percentage of value of annual production show a constant upward trend. For example, for the five years 1935 to 1939, this figure was 19.2 per cent, for the years 1940 to 1944 it was 25 per cent, and for the five years 1945 to 1949, 31.6 per cent. During the war when materials were restricted and the price of crude oil was at $1.15 a barrel, exploration expenditures were only 25 per cent of the value of the oil produced. During the five years since the war and when the average price was $1.67 a barrel, expenditures for exploration rose to 31.6 per cent of the value of the oil produced. From experience data covering the last three years, the average cost of a wildcat well was $160,000, but as only one in five was productive, the true cost per productive wildcat was $800,000. It is evident that an increasingly larger part of the industry's earnings are necessary for exploration if available domestic oil reserves are to be maintained on a basis commensurate with national safety and security.

The maintenance of an adequate ratio between available domestic oil reserves and domestic demand is essential in the national interest. What that ratio should be is problematical. It should be maintained at a higher level than at present to insure ample self-sufficiency in oil reserves. To do this, increasingly greater expenditures for exploration are inevitable.—K.C.S.

[1]Figure of 26,864,000,000 bbl in H. J. Struth's article on page A-33 is an error.

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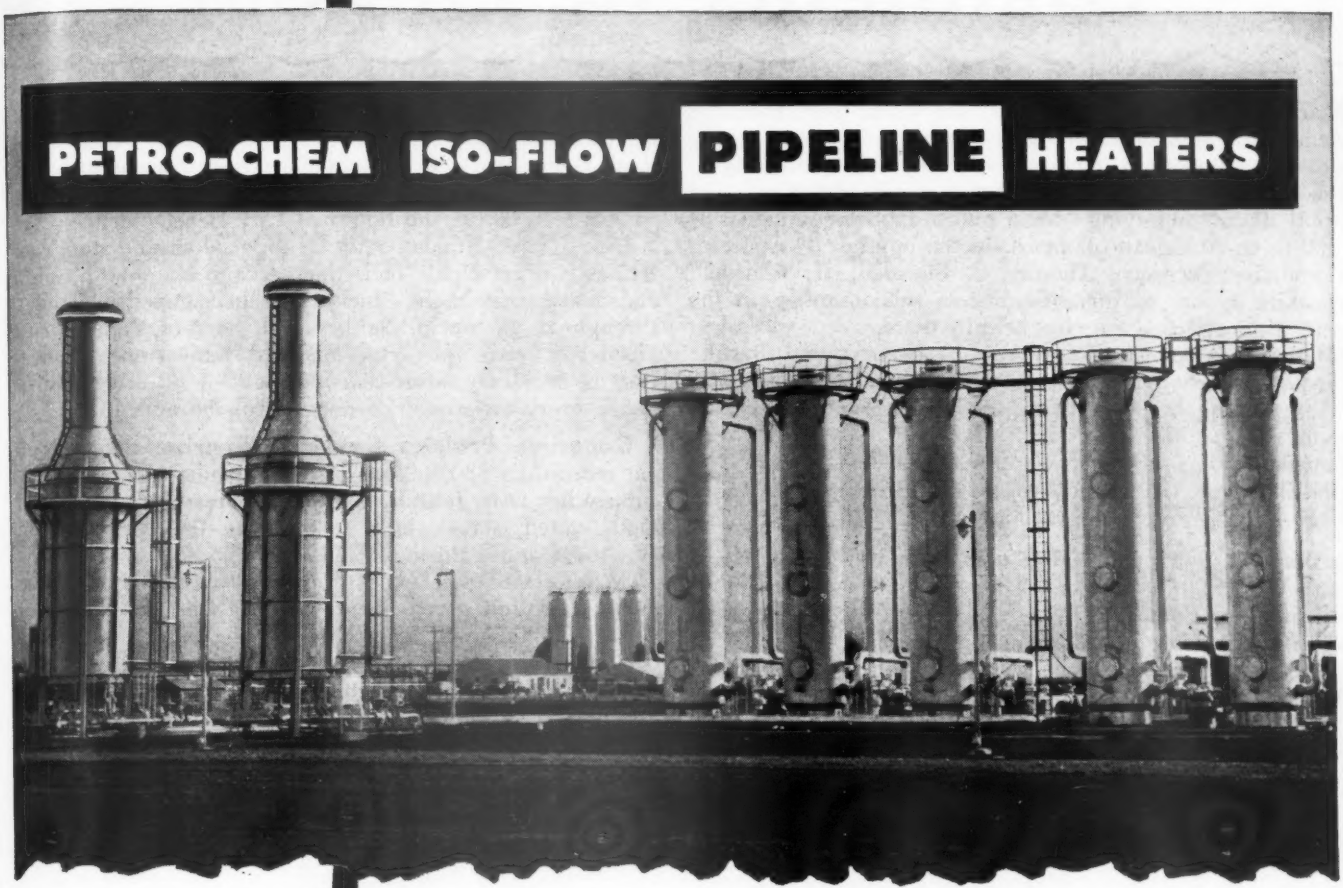

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Highlights in Oildom

Dollar Oil Talks Continue. The U. S. Government is demanding that Britain concern herself only with saving dollars, and not favor concerns of any one nationality at the expense of any other; in other words, Britain should apply its cuts in buying "dollar oil" to British companies as well as to American oil firms, in the opinion of Assistant Commerce Secretary Thomas C. Blaisdell, Jr. Blaisdell, speaking before a House Commerce subcommittee, at the same time attacked the view held by the domestic oil industry that it is being seriously hurt by imports, and that the government should restrict these shipments from overseas.

Further financing of British refineries through the Economic Cooperation Administration has been temporarily halted pending the outcome of Anglo-U. S. talks over the British ban of U. S.-produced oil into sterling areas, O. E. Bransky, chief of ECA petroleum branch, disclosed.

Dispute Synthetic Oil Costs. The Bureau of Mines and A. L. Solliday, executive vice president of Stanolind Oil and Gas Company, disagree emphatically on the costs of producing liquid fuels from oil shale and coal. In the Secretary of Interior's report to the Congress, he stated that jet, diesel, and residual fuels could be manufactured for 9 cents a gallon; the oil industry's estimate was 22.5 cents per gallon. Solliday, however, has charged the estimate was a product of wishful thinking, rather than cold hard facts, and added that the Bureau's figures leave out the cost of housing workers at remote mining areas and the cost of transportation of products from the mine to a market area. He further charged that the Bureau has computed its costs on low premium products such as jet, diesel, and residual fuels, which have little market value or demand, whereas the industry has based its cost on high premium motor gasoline.

Federal Programs Harm Oil Industry: Hallanan. "If the philosophy represented by the assaults now being made upon the oil industry had been national policy for the last 50 years, we would have lost World War I, and would have been annihilated by our enemies in World War II," Walter S. Hallanan, president of the Plymouth Oil Company, told members of the Western Petroleum Refiners Association meeting in San Antonio, Texas recently. Hallanan, chairman of the National Petroleum Council, appointed by the Secretary of Interior to inform the government about oil, charged that the oil industry is faced with governmental programs that would "present ruinous levels, reduce depletion allowances, and brand oil producers as tax dodgers," and yet it is expected to expand reserves and facilities, and build up enormous surpluses to insure national security.

Shell Research Program Expanded. A record research program in 1950 will cost the Shell Oil Companies about $1,500,000 a month. The research fields that will receive major attention, according to H. S. M. Burns, president of Shell Oil, are the development of new chemicals from petroleum and the development of agricultural products to enable farmers to grow more food at less cost.

He emphasized that the $18,500,000 earmarked for research in 1950 would support various Shell laboratories throughout the world, although the major portion of the budget would go to four principal U. S. research centers. These are Emeryville and Modesto, California; Houston, Texas, and Wood River, Illinois.

Individual Initiative Threatened, Holman Declares. Government control may some day reach a point where there is no return to individual freedom Eugene Holman, president of Standard Oil Company (New Jersey), declared in a speech before the Board of City Development in San Angelo, Texas. Holman referred to freedom and state control as two principal "fuels that serve to energize people", and noted that these "fuels" are in competition today throughout the world. Neither fuel, he said, can be used absolutely "pure". A certain amount of government regulation is necessary while absolute control of every individual's every act would be impractical, he added.

Canadian Prairies Develop. Western Canadian oil cut more than $30,000,000 off the oil bills of prairie consumers last year, John R. White, vice president of Imperial Oil Limited, stated, in a talk before the University of Western Ontario Business Club.

White stated that expenditures of the oil industry on exploration and development, now running at the rate of $150,000,000 a year, together with the more than $125,000,000 being spent on pipe lines, refineries, and other projects were obviously stimulating western prosperity and providing new opportunities for businessmen.

Crude Oil Reserves by States. Below are the figures released by the American Petroleum Institute, showing proved reserves by states in 1949.

(In thousands of barrels)

	Proved reserves as of Dec. 31, 1948 (1)	Changes in proved reserves due to extensions (new crude oil) and revisions during 1949 (2)	Proved reserves discovered in new fields and in new pools in old fields in 1949* (3)	Production during 1949 (4)	Proved reserves as of Dec. 31, 1949 (cols. 1+2+3 less col. 4) (5)	Changes in reserves during 1949 (col. 5 less col. 1) (6)
Alabama	3,547	448	.....	448	3,547	.....
Arkansas	300,042	23,130	2,412	28,121	297,463	—2,579
California	3,763,583	225,915	166,195	332,942	3,822,751	59,168
Colorado	365,458	2,719	50	23,415	344,812	—20,646
Illinois	393,365	126,909	11,816	63,952	468,138	74,773
Indiana	49,079	2,747	7,855	9,472	50,209	1,130
Kansas	674,395	136,379	27,755	100,139	738,390	63,995
Kentucky	59,209	2,875	3,540	9,456	56,168	—3,041
Louisiana	1,869,290	179,699	43,695	182,915	1,909,769	40,479
Michigan	69,383	9,443	4,217	16,547	66,496	—2,887
Mississippi	365,446	71,034	2,114	35,734	402,860	37,414
Montana	118,944	2,827	272	9,650	112,393	—6,551
Nebraska	865	400	650	291	1,624	759
New Mexico	552,231	46,204	41,266	47,479	592,222	39,991
New York	67,116	.....	.....	4,216	62,900	—4,216
Ohio	28,542	2,646	.....	3,485	27,703	—839
Oklahoma	1,250,401	197,240	33,056	150,779	1,329,918	79,517
Pennsylvania	109,806	5,000	.....	11,450	103,356	—6,450
Texas	12,484,218	1,229,877	531,984	736,347	13,509,732	1,025,514
Utah**	807	15,050	600	626	15,831	15,024
West Virginia	36,697	3,000	1,125	2,830	37,992	1,295
Wyoming	715,787	11,934	11,815	47,934	691,602	—24,185
Miscellaneous**	2,233	1,952	.....	572	3,613	1,380
Total U. S.	23,280,444	2,297,428	890,417	1,818,800	24,649,489	1,369,045

* Only a limited area is assigned to each new discovery, even though the committee may believe that eventually a much larger area will produce; for, in this report, the concern is only with actually proved reserves.

** In our report for Dec. 31, 1948, the reserves under "Miscellaneous," which included Florida, Missouri, Tennessee, Utah and Virginia, were recorded in column 5 as 3,040,000 bbl. In our present report Utah, with 807,000 bbl. out of this 3,040,000 bbl., is listed separately, the other four states still remaining under "Miscellaneous."

Natural Gas Added During Year. Below are figures released by American Gas Association.

(Millions of cubic feet)

	Extensions and revisions	Discoveries of new fields and new pools in old fields	Total of discoveries revisions and extensions	Net change in storage	Net production during year	Estimated proved reserves as of end of year	Increase over previous year
1945	.....	.....	.....	.....	.....	147,789,367	.....
1946	(*)	(*)	17,729,152	(*)	4,942,617	160,575,901	12,786,535
1947	7,570,654	3,410,170	10,980,824	(*)	5,629,811	165,926,914	5,351,013
1948	9,769,483	4,129,089	13,898,572	51,482	6,007,628	173,869,340	7,942,420
1949	8,061,429	4,612,870	12,674,299	82,746	6,245,041	180,381,344	6,512,004

(*) Not estimated.

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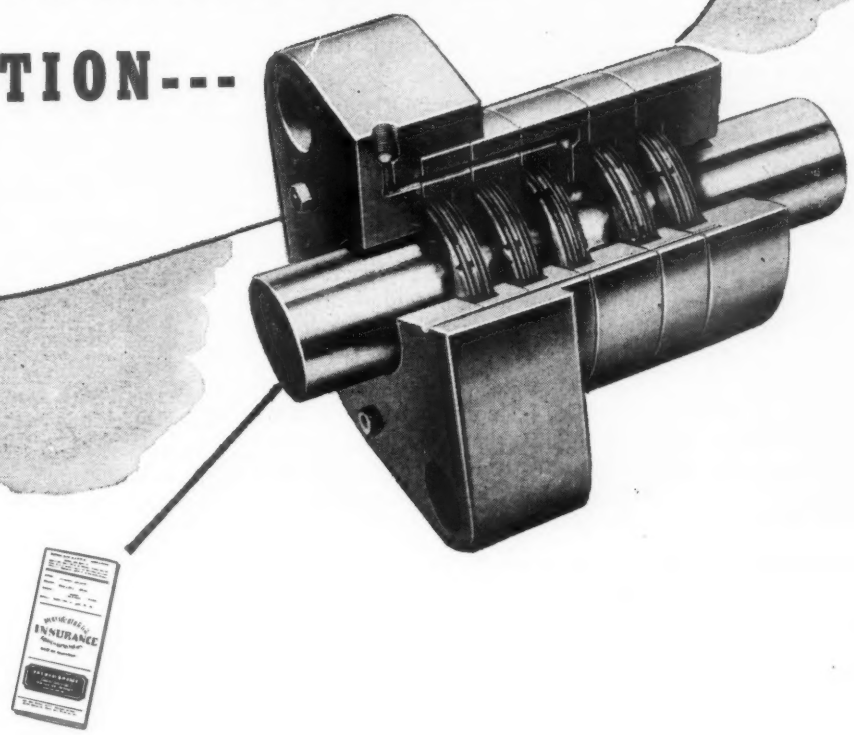

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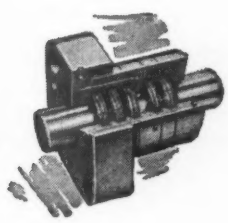

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Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Uncertainty clouds the future of government-industry cooperation in oil with indications that hidden forces are working to drive a wedge between the Interior Department and the National Petroleum Council.

For months, there have been rumors that some White House advisers felt that the NPC was having "too much to say" about government oil policies. But the first hostile move has come from Capitol Hill.

Taking the position that "active government cooperation with the petroleum industry" is no longer needed, the House Appropriations Committee recommended that Interior's Oil and Gas Division be abolished or substantially reduced. Since OGD has been the contact point for NPC, the implication was that the Council was not needed either.

This comes at a time when vital oil issues—such as imports, depletion allowance, and tidelands leasing—are coming up for decision and talk is increasing about the "need" for development of a national oil policy.

Also, it finds the industry's standing here—if not in other non-oil areas—at its lowest point in many years as an aftermath of the bitter campaign against the depletion allowance and the Kerr Gas Bill to exclude from the Federal Power Commission's control the arm's length sales of gas by independent producers.

Fuels Commission. Coal-state representatives are trying to broaden President Truman's legislative request for a coal investigative commission into a comprehensive study of all forms of energy with a view to developing an overall policy on fuels, including the reserves, prices, and uses thereof. Behind this move is the hope of halting the trend away from coal to oil and gas. "While oil and gas are useful as supplementary fuels," said Senate Majority Leader Lucas (D, Illinois) in endorsing the idea of a fuels study, "we should not dip into our oil and gas reserves while we have such a plentiful supply of our basic fuel economy—coal."

Imports. The coal people are blaming much of their trouble on imported fuel oil. So, it is certain that any fuels study will include a look at the oil imports problem with perhaps some recommendation for a permanent solution. Meanwhile, several stop-gap plans are still being discussed at top-level government circles, hoping to quiet complaints. Action is still being promised—soon.

One idea is to cancel the Mexican reciprocal trade agreement, which would automatically restore provisions of the Venezuelan agreement providing for a 21-cent tariff on imported crude and fuel oil over and above 5 per cent of the previous year's refinery runs, or about 300,000 bbl a day.

IPAA's Position. Independent Petroleum Association of America would rather see imports reduced by voluntary action of the companies involved—but until there is concrete evidence that the importers are willing to moderate the flow of foreign oil into the United States, the IPAA will be compelled to press for legislative relief either through a higher tariff or import quotas. Such was the comment by Russell Brown (IPAA) during a recent conference with Interior Secretary Chapman.

Chapman told Brown that he favored the voluntary approach through government-industry cooperation rather than legislation. Chapman made it clear, however, that he recognized the "seriousness" of the import situation and believed that the independent producer's worries were not unfounded.

"Independent oil producers have reason to be concerned over the import situation and something should be done to protect them," Chapman told Brown.

ECA. If the ideas of Senator Lodge (R, Massachusetts) prevail in final action on the ECA Bill, then the American producer and refiner not only stands to lose even more of his export market but will be faced with the threat of still more surplus oil from Venezuela. Lodge wants the ECA to require that petroleum requirements under the Marshall Plan be supplied with the least expenditure of dollars, giving preference to areas where the oil has the least dollar component. Middle East oil is supposed to have a dollar cost of only 20 per cent compared with 60 per cent for Venezuela. Displaced oil from Venezuela would then be seeking a market here.

British Oil. But Senator Lodge's views may not prevail. There has been a stiffening of resistance both within the Truman Administration and in Congress against British "discrimination" against American-owned oil in world markets.

State Department is completing a proposal for easing British restrictions under which American companies would be allowed to compete—with payment in sterling—in supplying (1) the 4,000,000 tons annually of fuel oil and gasoline displaced by British oil recently in the United Kingdom, (2) the 3,000,000 tons displaced by British deals with such countries as Argentina and Sweden, and (3) any additional quantities in non-sterling areas, over and above normal requirements for sterling oil, which the British are willing to have supplied by American countries.

Originally, the State Department's proposal contemplated that American companies could convert to dollars 30 per cent of the sterling received for sales in any of these three categories, with the balance in inconvertible sterling, which could be spent only for certain British goods. But the 30 per cent figure was deleted and the exact percentage left for later negotiations, after American companies had objected that the dollar content of British oil, worldwide, averaged much more than 30 per cent.

Depletion. It's still an uphill fight to continue the 27½ per cent oil-gas depletion allowance unchanged, with Treasury prepared to renew its attack when the tax bill reaches the Senate side. President Truman may issue another blast. At best, the fight will only be deferred. Some sort of token change seems likely as a gesture to placate the White House. Oil-states congressmen, however, are becoming more confident that the Treasury will not succeed—this year, anyway—in getting the allowance reduced to 15 per cent.

Tidelands. The betting is about even that Texas will not lose the tidelands suit, now awaiting decision by the Supreme Court. This is due to the magnificent defense put up by Texas Attorney General Price Daniel. Unlike Texas, Louisiana's situation was similar to that of California, which lost out in the first tidelands case. So, the odds are against Louisiana.

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National Petroleum Situation

By H. J. STRUTH,* *Petroleum Economist*

Stocks Sharply Reduced. Preliminary supply and demand data for February indicate a sharp reduction in stocks of crude oil and refined petroleum products. Stocks of all oils on February 28 aggregated 578,010,000 bbl, which was a reduction since January 31 of about 14,000,000 bbl. Stocks are about 6 per cent less now than a year ago. They represent about 85 days supply against 99 days supply a year ago. Crude stocks were reduced in February by about 2,300,000 bbl, while stocks of products, including natural gasoline, were cut about 12,000,000 bbl.

Demand Greater. Demand for all oils rose to a daily average in February of 6,806,000 bbl, which was about 213,000 bbl a day greater than in January. In the first two months of this year, demand was 6 per cent above the same period of last year, while the supply was reduced about 3 per cent. Demand for fuel oils in the first two months of this year was about 8 per cent above last year, while the demand for motor fuel increased about one per cent above last year. The demand for all fuel oils in January was approximately 13 per cent above a year ago.

Crude Oil Curtailment. Crude oil supply in the first two months of this year was about 7 per cent below last year. Crude oil production in the United States was reduced 8 per cent below last year. The daily average in the first two months was 4,940,000 bbl, against last year's daily average of 5,383,000 bbl. Advance estimates place imports of crude oil at about the same level as a year ago. The February rate was about 506,000 bbl daily.

Refinery Runs Reduced. Runs to stills in February were cut about 173,000 bbl daily. Runs in the first two months of this year were about 3 per cent below a year ago. Rising stocks of motor fuel prompted U. S. refiners to cut the yield of this product to 39.4 per cent, which compares with an average yield in January of 42.8 per cent. Yields of distillate fuel oils were increased in February. However, the production of fuel oils in the first two months of this year was reduced about 6 per cent below a year ago, whereas the demand for these products was 8 per cent greater. As a result, fuel oil stocks represent about 31 days supply, compared with 40 days supply a year ago.

*Petroleum Consultant, Dallas, Texas.

Comparative Statistics, February, 1950

*All figures are computed on a Bureau of Mines' Basis**

	Feb. 1950Ⓟ	Jan. 1950	Feb. 1949	This Year to date	Last Year to date	Per cent change
Total supply*, all oils	176,120	193,735	179,317	369,855	378,617	— 3
Daily average	6,290	6,250	6,404	6,268	6,417	
Total demand‡, all oils	190,567	204,397	173,576	394,964	370,071	+ 6
Daily average	6,806	6,593	6,199	6,694	6,272	
Change in stocks	—14,447	—10,662	+ 5,741	—25,109	+8,546	
Crude supply*	153,050	167,692	162,882	319,742	343,829	— 7
Daily average	5,430	5,409	5,817	5,420	5,828	
Crude demand‡	155,310	174,438	156,314	329,748	335,240	— 2
Daily average	5,546	5,627	5,583		5,682	
Crude stocks	244,350	246,610	265,216	244,350	265,216	— 8
Days supply	44	44	47	44	47	
Natural gasoline production	13,100	15,063	12,070	28,163	25,057	+12
Daily average	468	486	431	477	425	
Motor fuel production	71,850	82,043	71,357	153,893	152,136	+ 1
Daily average	2,565	2,647	2,548	2,608	2,579	
Gasoline yield per cent	39.4	42.8	41.6	40.8	41.2	— 0.4
Motor fuel demand‡	62,987	68,473	61,594	131,460	128,672	+ 1
Daily average	2,249	2,209	2,200	2,228	2,181	
Motor fuel stocks	132,850	123,987	124,524	132,850	124,524	+ 6
Days supply	59	56	57	59	57	
Fuel oil production	60,575	69,980	64,019	130,555	139,034	— 6
Daily average	2,163	2,257	2,286	2,213	2,357	
Fuel oil demand‡	90,155	96,794	80,023	186,949	172,328	+ 8
Daily average	3,220	3,122	2,859	3,168	2,921	
Fuel oil stocks	100,110	119,740	113,335	100,110	113,335	—11
Days supply	31	38	40	31	40	
Refinery still runs	148,695	169,987	153,440	318,682	328,735	— 3
Daily average	5,310	5,483	5,480	5,401	5,572	
Stocks, all oil	578,010	592,457	614,289	578,010	614,289	— 6
Days supply	85	90	99	85	99	

Current Crude Oil Prices

U. S. Average $2.54	Louisiana $2.62	Basic crude prices:	
Texas 2.61	Arkansas 2.43	Oklahoma-Kansas (36 gr.)	$2.57
California 2.42	New Mexico 2.40	Texas Gulf Coast (36 gr.)	2.80
Oklahoma 2.62	Mississippi 2.26	East Texas	2.65
Kansas 2.62	Illinois 2.76	West Texas (36 gr.)	2.44
	Other states 2.60	California Signal Hill (36 gr.)	2.31
		Pennsylvania, Bradford	3.40

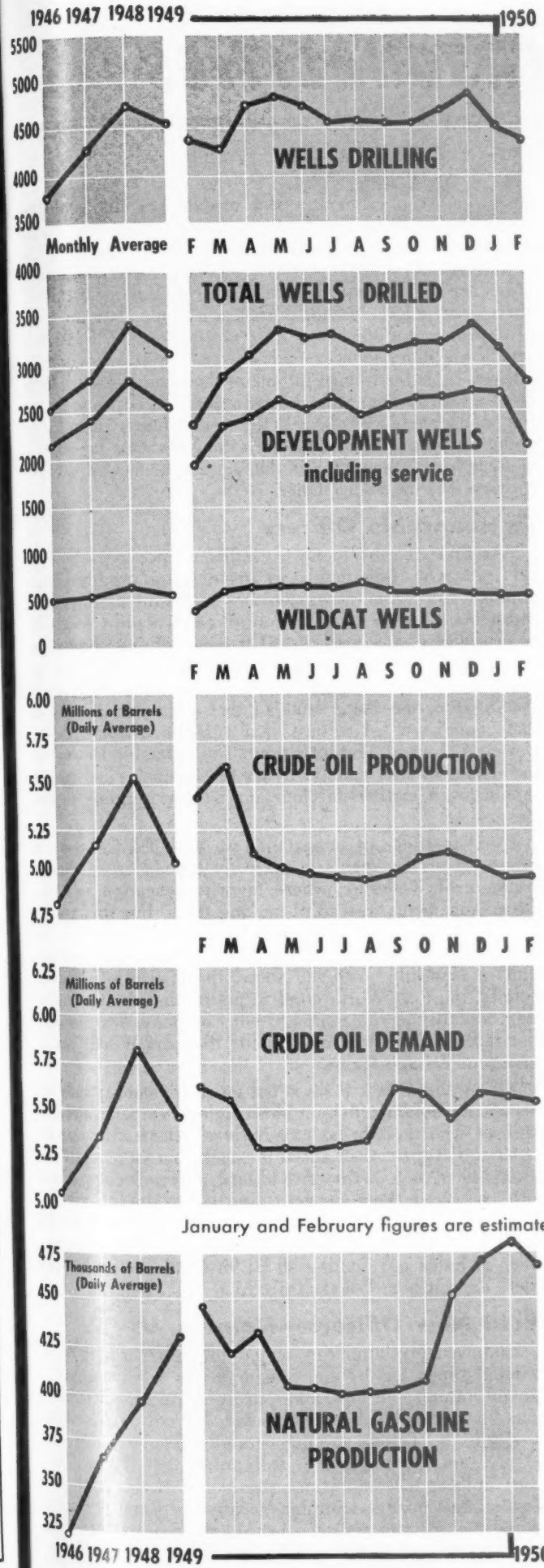
Drilling and Production Statistics

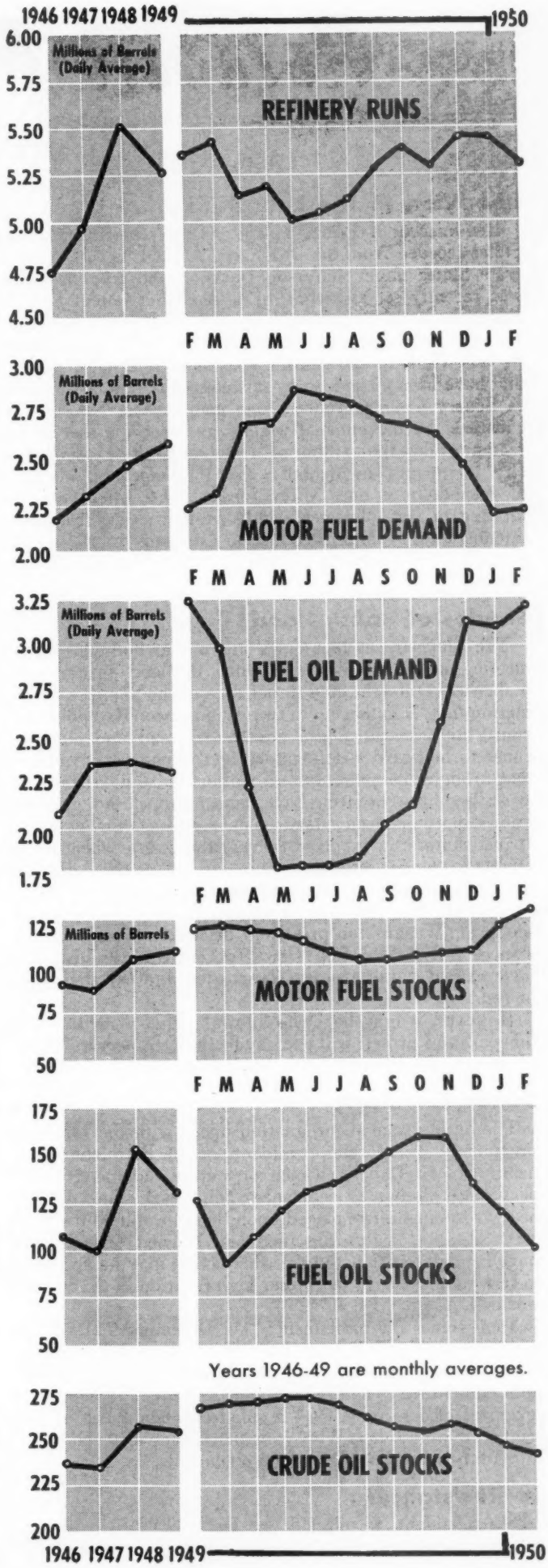
	Feb. 1950Ⓟ	Jan. 1950	Feb. 1949	This Year to date	Last Year to date	Per cent change
Wells Drilling	4,455	4,585	4,526	4,455	4,526	— 2
Total wells drilled	2,822	3,255	2,358	6,077	5,696	+ 7
Development wells	2,210	2,630	1,880	4,840	4,525	+ 7
Oil	1,537	1,818	1,309	3,355	3,151	+ 6
Gas	160	210	185	370	402	— 8
Dry	513	602	386	1,115	972	+ 15
Per cent dry	23.2	22.9	20.4	20.0	21.4	— 1.4
Service wells	65	92	104	157	237	— 34
Wildcat wells	547	533	374	1,080	934	+ 16
Oil	75	90	57	165	138	+ 20
Gas	20	20	9	40	19	+111
Dry	452	423	308	875	777	+ 13
Per cent dry	82.6	79.4	82.4	81.0	83.4	— 2.4

By State

Wells drilled (excl service)	2,757	3,163	2,254	5,920	5,459	+ 8
Arkansas	29	34	23	63	27	+133
California	138	152	186	290	453	— 36
Illinois	140	210	166	350	350	0
Kansas	258	253	197	511	432	+ 18
Louisiana	160	240	155	400	370	+ 8
Mississippi	21	28	21	49	50	— 2
New Mexico	57	62	46	119	87	+ 37
Oklahoma	352	370	184	722	531	+ 36
Texas	1,164	1,256	785	2,420	2,016	+ 20
Other states	438	558	491	996	1,143	— 13
Wildcats drilled	547	533	374	1,080	934	+ 16
Arkansas	11	10	4	21	6	+250
California	31	26	37	57	90	— 33
Illinois	43	47	19	90	53	+ 70
Kansas	50	40	28	90	72	+ 25
Louisiana	23	29	17	52	36	+ 44
Mississippi	9	7	3	16	15	+ 7
New Mexico	9	7	7	16	22	— 27
Oklahoma	62	70	34	132	107	+ 23
Texas	253	211	164	464	398	+ 17
Other states	56	86	61	142	135	+ 5
Daily crude production	4,958	4,922	5,376	4,940	5,383	— 8
Arkansas	85	86	87	86	86	0
California	867	867	947	867	943	— 8
Illinois	172	165	173	168	170	— 2
Kansas	278	270	289	274	286	— 5
Louisiana	564	560	523	562	522	+ 7
Mississippi	96	98	108	97	112	— 14
New Mexico	131	131	136	131	133	— 2
Oklahoma	435	394	422	415	429	— 3
Texas	1,953	1,962	2,332	1,955	2,333	— 6
Wyoming	156	150	116	153	125	+ 22
Other states	221	239	243	232	244	— 5

*Unless otherwise stated all figures represent thousands of barrels. Ⓟ-Preliminary. *Includes domestic production and imports.
‡Total demand, including exports.
Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.


1946 1947 1948 1949
1950
WELLS DRILLING
Monthly Average
F M A M J J A S O N D J F
TOTAL WELLS DRILLED
DEVELOPMENT WELLS
including service
WILDCAT WELLS
CRUDE OIL PRODUCTION
Millions of Barrels (Daily Average)
CRUDE OIL DEMAND
Millions of Barrels (Daily Average)
January and February figures are estimates
NATURAL GASOLINE PRODUCTION
Thousands of Barrels (Daily Average)


1946 1947 1948 1949
1950
REFINERY RUNS
Millions of Barrels (Daily Average)
MOTOR FUEL DEMAND
FUEL OIL DEMAND
MOTOR FUEL STOCKS
FUEL OIL STOCKS
Years 1946-49 are monthly averages.
CRUDE OIL STOCKS

PETROLIC PERSONALITIES

DICK SNEDDON

Rebellion in the Low Ranks

Reminiscent of the hectic days of 1861, when the Southern States seceded from the Union and formed its own Confederate States under Jefferson Davis, is the revolution that was recently set awhirling by a small but potent band of renegades in the Petroleum Engineers Club of Dallas, Texas. This ordinarily peaceful institution has lately been rent to its very vitals by devastating spasms of internal dissension that have been picked up by seismograph crews as far away as Scurry County. Indeed, one geophysicist has been so exercised by the unusual wiggles on his chart that he has recommended the drilling of a well. A pretty kettle of fish, eh? It appears, incidentally, that the leader of this band of desperados is one Dewey Jordan, who, when he is not inciting to riot, officiates calmly enough as general superintendent for Atlantic Production Company in Dallas, and is in all normal respects a perfectly rational and trustworthy person.

Shades of Robin Hood

The whole fracas blossomed into a near donnybrook one meeting noon not long ago when the said Jordan, with malice aforethought, and in defiance of the Sheriff's proclamation that "a gathering of two or more would undoubtedly constitute a mutiny," did nonetheless read and otherwise cause to be heard a defamatory and inflamatory statement that brought disrepute and discomfort on some certain citizens, thereby committing laches and estoppel and, goodness knows, perhaps even *habeas corpus* and *e pluribus unum*. It just shows how involved things can become when one attempts to tamper with the *status quo*, or, as the politicians say, "change horses in the middle of a scream."

Anyway, The Petroleum Engineer is more than proud to scoop the Washington press and disclose not only the substance of the scurrilous "Dewey docket", as the historians have named it, but also the signatories, and will their faces be red.

However, it may be—who knows?—that a recitation of this paean of protest will one day be the "Hippocratic Oath" of the petroleum engineering profession.

Dallas Tea Party

The declaration of indignation opens with the following preamble: "The former presidents of the Petroleum Engineers Club of Dallas, all men of mature judgment, with a deep sense of civic consciousness, being ever mindful of the heavy responsibilities placed upon them to uphold the highest traditions of this dignified and learned organization, have banded together to take what action may be necessary to restore this club to its former high position in the cultural world."

Then comes the indictment: "On December 9, 1949, the members of this Club, in an hour of weakness, influenced by the wonderful ambrosia and delightful horsemeat hamburgers, unwittingly nominated and subsequently elected a group of officers for 1950—a small number of whom you see before you today. With your permission I propose now to read the record of their accomplishments.

La Resistance!

"As president, we elected one Hank Gruy, a fellow addicted to cowboy hats and foreign dialect jokes. His attendance has been as erratic and unstable as his geological contours, which he always draws with a lead pencil. He has been present so seldom that when he does show up he has to introduce himself to his fellow cabinet members, and his jokes are a complete reversal of the Euclidian postulate—they have length, breadth, and magnitude, but no point. His own recitations move him to great gusts of laughter, which are more than ever emphasized by the surrounding silence. He is the living epitome of the man who said, 'I can hardly wait to hear what I have to say.' It is probable that his poor attendance is largely the result of an avidity for the composition of punchless poetry, and his poor breeding is evident, heaven help him, in the fact that he has been known to burp into the microphone.

So Honorable Officers

"As first vice president, we inflicted upon ourselves one Ed Cram, who often doubles as president and program chairman. He too extols his own virtues each time he introduces himself and writes his name on all cards within reach. He is so unlucky, however, that if it were raining champagne he would be out in it with a two-tined fork. His one real claim to respectability is that he comes from the state of Washington, the home state of that estimable gentleman, that connoisseur of culture, that paragon of good taste—Dewey A. Jordan. (Editor's note: The estimable Dewey was the reader of this eulogy, if not the composer, so readers should await further developments before jumping to conclusions.)

"Next in order of importance we have Ed Caraway, in charge of arrangements, a perfectly kissable rosy-cheeked graduate of Wellesley, whose favorite avocation is eating the arrangements instead of making them. For this reason, his constituents often have to go hungry. Then there is Pete Brainard, who reached Dallas by way of Mattie's Dance Hall, a traveling medicine show, the sheriff of Midland County, the Fort Worth chief of police, and finally the benign credulity of the Seaboard Oil Company. We maintain that if Pete ain't good enough for the Fort Worth jail he ain't good enough for us.

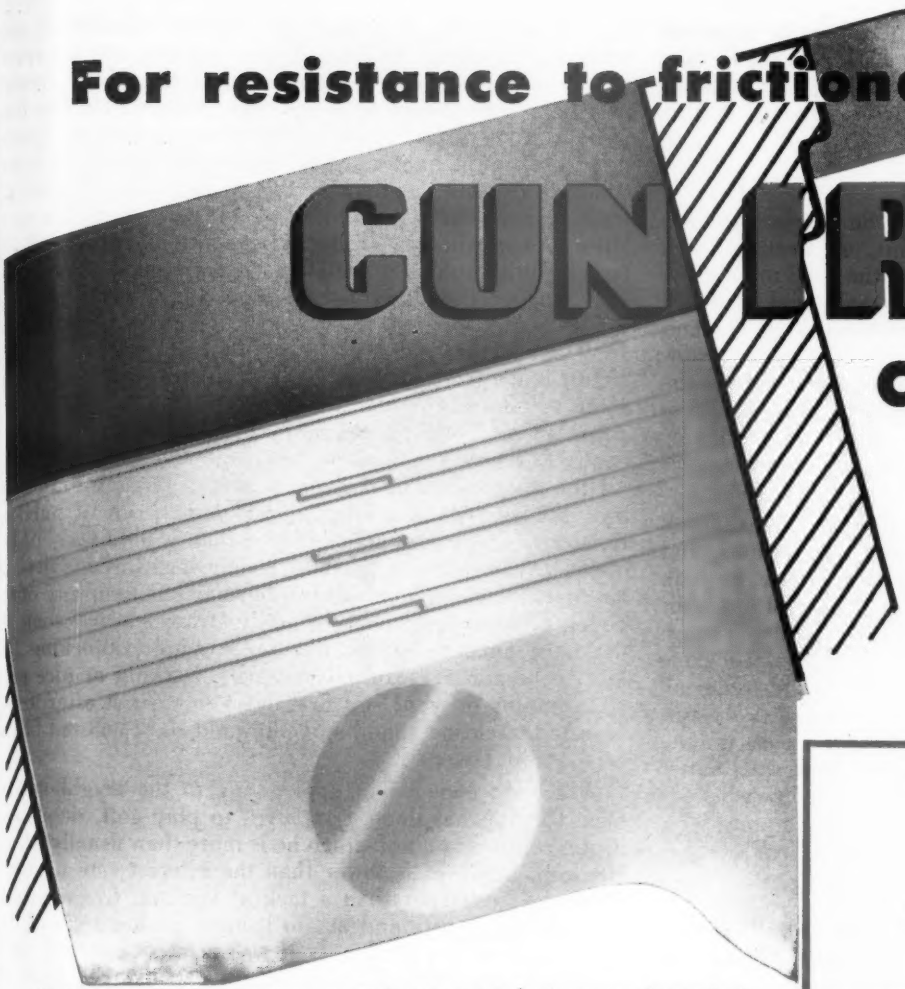
"Of another officer there is not much we can say. He was mistakenly nominated by a short-sighted confederate sympathizer who thought he was *Jefferson* Davis. He was for a time the proprietor of a neat mustache but he recently had it amputated as a distinct fire hazard, and now goes around with his face in the nude. Last, but best of the lot, we have Renfro, who has been here every time the cops and his bonding money would let him. Being secretary and treasurer, he holds our funds—all $1.98 of them—in his own safety deposit box. We can't fire him.

Want New Officers—Namely, Us

"Summarizing, after this review of the record, it is our opinion, supported by due consideration, a ouija board, a pair of bottoms and tops, and a profound algebraic summation, that we could not have selected a group of officers filled with more ennui and innocuous desuetude than Messrs. Gruy, Cram, Caraway, and Brainard. For it is the unanimous opinion of the former presidents of this club that these miscast misfits, with the exception of Rummy Renfro, be impeached, and replaced by Messrs. Sanders, Jackson, Carpenter, Potter, Jordan, Fagin, Bacon, Fuller, and Parker.

For resistance to frictional wear...

GUN IRON CASTINGS



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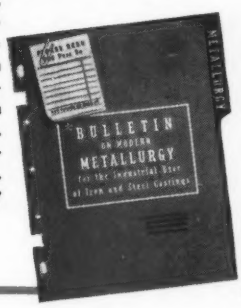

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We will work in shifts so that there will always be dignified and qualified officers present. Signed: L. T. Potter, Horace Sanders, Charles Carpenter, Marshall Fagin, Ham Bacon, Warren Jackson, John Fuller, Peter Parker, and D. A. Jordan." *Quad erat demonstrandum!*

Seeded No. 1 in Ping Pong

Up in the Rocky Mountains, among the yodelers and the boys with the alpenstocks and slaloms, we hear tell that Nebraska U's favorite grad, Al Barrett, the head representative of the Flying Horse up thataway, is really making a fine impression. Al used to be geologist for the Prairie Oil and Gas Company in Casper, Wyoming, but went into consulting work when business became almost *non est* during the depression. Later he tied in with General Petroleum Corporation and knows the geology and the people of the Rocky Mountain country now like a gypsy fortune teller knows her own palm.

First hired as a geologist for G.P., he ascended the ladder of success through a series of rapid promotions, and when Red Hardison recently went into retirement, he took over the top spot. Al, in his spare moments goes out after elk, deer, or sage chicken, but when the snowfall won't permit venturing too far afield, can be inveigled into a game of bridge, the which he plays so well that Jacoby and all the experts stay strictly away from the snowed-in fastnesses. A more strenuous sport in which Al Barrett excels is ping pong, a sort of juvenile tennis that is played with butter spades, under a table 9 ft x 5 ft. We know a fellow who was once down on his hands and knees under a ping pong table looking for a lost ball—and found a wife. Oh well!

A Liar Dice Expert

Another member of the Rocky Mountain hill-billies who has really made good is Paul Kartzke, division manager at Casper for the Shell Oil Company. Paul joined up with the Shell Company immediately after he graduated from Cal Tech, and then went through the trainee routine in the engineering department, eventually winding up as superintendent at Coalinga. Thereafter he spent some time in San Francisco and Los Angeles, and then was made division manager at Bakersfield. Thence he moved to Casper, where he has thoroughly ingratiated himself with the localities and in consequence has a mighty nice time himself.

He is perhaps the best domino player north of the Petroleum Club in Los Angeles and has made some of the prettiest designs ever made in a match. He also swings a vicious ping pong paddle, and is reputed to be the petroleum industry's No. 1 exponent of liar dice. It is said that he has even beaten Bill Goertz, the good looking Axelsonian, who has literally controlled the fibbing cubes for the past decade.

Mechanical Calculators Left at Post

We have just been told that Ham Miller, division comptroller for the Ohio Oil Company at Houston, Texas, has been out here on the Coast for several days to see if it is true what they say about Los Angeles. At this writing he has experienced eighteen different kinds of weather including hot, cold, and unusual. He has been embattled by fog, smog, and even a sprinkling of sunshine, and already he has had enough atmospheric adventure to justify the writing of a book. He has visited, among other things, California's two model recycling plants — Paloma and Coles Levee, so he won't be taken by surprise when the Ohio Oil Company starts its new plant at Bay City one of these fine days.

Ham has also been doing a bit of reconnaisance work at the Los Angeles Petroleum Club in the hope of picking up an idea or two for the Houston Club. It might be mentioned in passing that the Mynheer Miller is one of the fastest men with figures on the Gulf Coast. We have heard it said that the manufacturers of slide rules, electric calculators, and other mathematical instruments and devices, test the speed and accuracy of their gadgets against the Miller mental processes and usually fall hopelessly behind. He has that knife keen perception that enables him to spot an upside down decimal point at a distance of twenty feet. There is one thing about these brilliant minds, though that we have always found difficult to understand. For example, we once knew a chap who was really an accounting genius, and yet he was quite unable to satisfactorily account for some lipstick on his collar, and this caused no end of trouble.

A Man's Best Friend

Just down from San Franciso to Los Angeles in the deep south to take over public relationswise for Shell Oil Company is Carl Totten, a pleasant and accomplished lad, eminently fitted by qualification, temperament, and experience, for the assignment. Carl is a graduate of Oregon State College in business administration, has done a raft of publications work, and has more hobbies than a hobby shop. He claims to have one of the best watch dogs in captivity—it has watched more homes being burglarized than any other pooch of its age. And, all by itself, it has learned some of the most amazing tricks, like for example, knocking the lid off the garbage can, chasing cats, barking at nice people, jumping on your suit first day you wear it after it has been to the cleaners, and spreading old dark colored bones on the front lawn.

When not engaged in apologizing to the neighbors for what the dog has done, Carl loves to play golf, dominoes, or gin rummy, at all of which he is more than usually adept. His golf handicap is lower than the interest rate in Aberdeen; he is sharper than a tack at spotting five multiples in a domino joust; and at gin rummy he has lowered the mains'l of many a trim craft, if we may wax nautical—and we would like to see anybody try to stop us. But what we were about to say when we were so rudely interrupted was that with all his natural talent and uncanny skill, Carlos can be taken—and is. Some twenty years ago he married a young lady who can whip him with consummate ease at any of the aforementioned pastimes. 'S humiliatin', that's what it is! Anyway to wind up this saga we should perhaps make it known that Carl has been appointed publicity chairman for the Petroleum Production Pioneers, and what with his normal duties will certainly be fully occupied during the balance of 1950.

And So Adieu . . .

Our good friend and ex-domino partner, Paul Broxon of Western Gulf's legal staff, is home from the hospital, as we write, following an eye operation. Paul is a grand person and we know there are many joining with us in the hope that his trouble, whatever it is, may be responsive to treatment, so that he will soon be back on deck again. Incidentally, the lads who so ignominiously trimmed Paul and me in the first round of the Petroleum Club domino tournament, won out in the finals, so we don't feel too badly now. They were Reg Keans and Ray Stipek, and they beat Guy Edwards and Harold Hoots in a tough battle for the trophy. Roy Barnes is in the process of organizing a cribbage tournament for the Club, of which more later.

Henry Salvatori, president of the Petroleum Club has announced his standing committees, as follows — Finance: Phil Magruder, chairman; Paul Huggins, Mortimer Kline, D. Staples, and O. I. Torkelsen. House Committee: Rollin Eckis, chairman; Henry Paulsen, Dick Sneddon, G. S. "Duke" Follansbee, Jr., and Ed Bartosh. Saying which we leave you to your own devices. Remember, relatives are merely people who come to see you when it is too hot to do their own cooking.

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1½ to 3½ cubic yards per minute with PARSONS 250 TRENCHLINER

Model 221 ALSO SPEEDS SCHEDULES

- Smaller Parsons 221 ladder-type has full range of 30 digging feeds from 5 in. to 12 ft. per min.
- Telescopic boom digs up to 8½ ft. deep . . . quickly, easily adjusted at 1-foot intervals.
- Model 221 has 9 cutting widths, from 16 to 36 in. Special teeth and side cutters provide all width changes with only 3 standard-size buckets.
- Ask your Parsons distributor for complete facts on Trenchliner Models 221 and 250. 2 other sizes: bigger crawler-mounted 310, and utility-size, rubber-tired Model 80 offer consistent savings for every size pipeline job.

HEAVY-DUTY Parsons 250 Trenchliner sets a fast pipeline pace . . . excavates 1½ to 3½ cu. yards per minute, depending on materials, depth and width requirements. 30 digging feeds, from 3.8 inches to 9 feet per minute, provide maximum digging efficiency in all materials short of solid rock. You get clean-bottom, smooth-wall trenches 16 to 42 inches wide . . . up to 12½ feet deep.

What's more, the 250 Trenchliner maintains steady, high-speed schedules and assures lowest operating costs because every assembly is extra-heavy duty . . . from its husky, fast-cleaning buckets, to the rigid arch-type frame that keeps digging boom precision-aligned. Safety overload clutch protects operating machinery from shock-loads. 3-point frame suspension maintains equal weight distribution on uneven ground, keeps twists and strains from main frame. All add up to trouble-free operation, more feet of pipeline trench per day, at lowest cost per foot, with Parsons heavy-duty 250 Trenchliner.

PARSONS COMPANY, Newton, Iowa

PARSONS HEAVY DUTY KARING PRODUCT

PARSONS Trenchliners®

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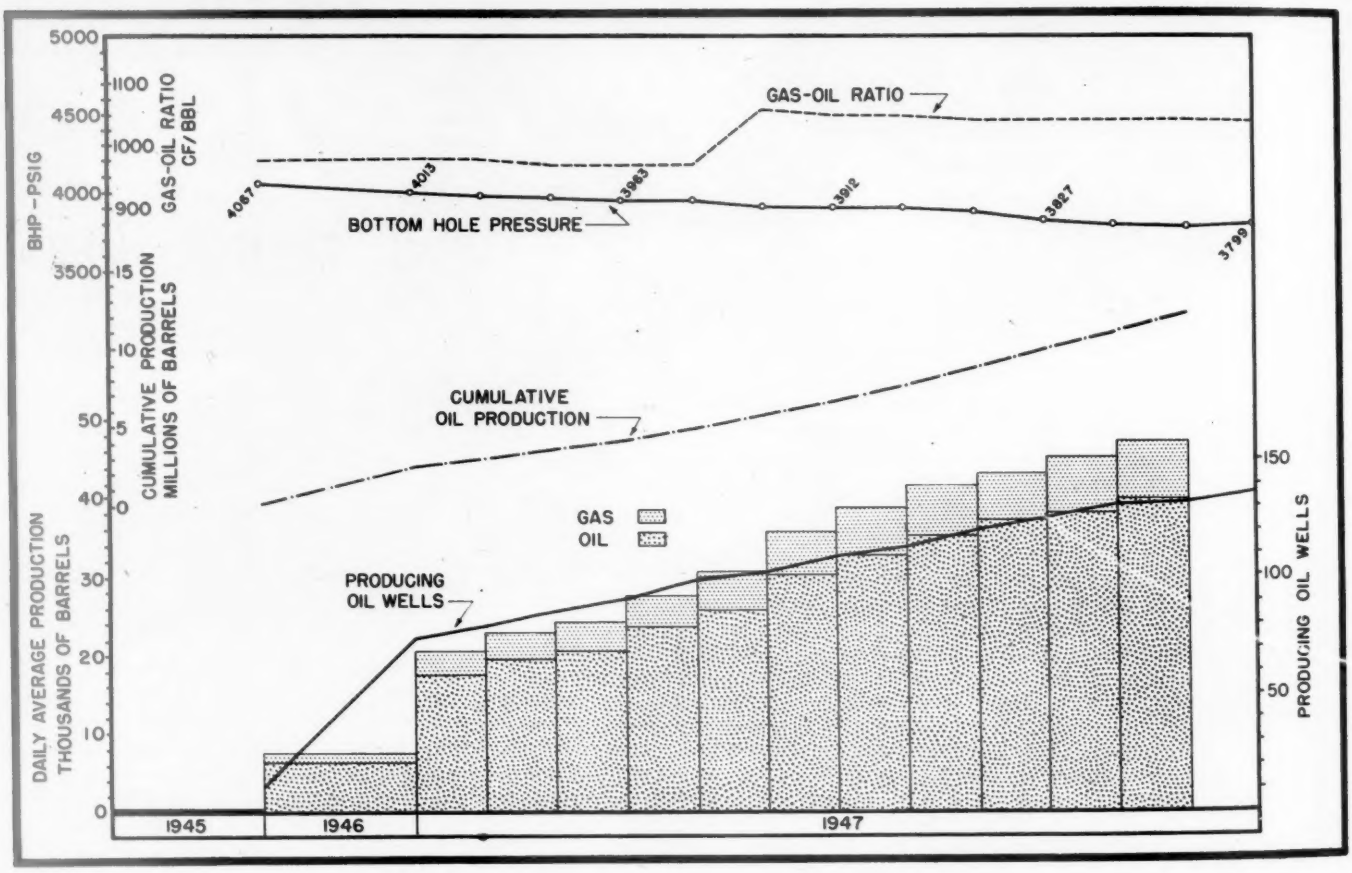
P37

T X L ELLENBURGER FIELD

Location —Texas. Ector County, 25 miles west of Odessa, Texas.
Type of structure —Faulted Anticline
Producing formation —Ellenburger Dolomite
Discovery well —Shell—Thomas, A-1
Current spacing pattern—40 acres —Average elevation—3,300′
Original water level (subsea)— —Current water level (subsea)—
Top of porosity (subsea)— —Effective section—250′
Bottom hole temperature—138° F Average porosity— Permeability—
Connate water— Form volume factor— Recovery factor—
Gravity of oil—44.0° API Gravity of gas—0.955 G.P.M. of gas—
Original operating GOR—975 —Current operating GOR—1,037
Reservoir pressure (subsea datum)—6,450 —Original—4,069 psig Current—3,799 psig



PRODUCTION STATISTICS

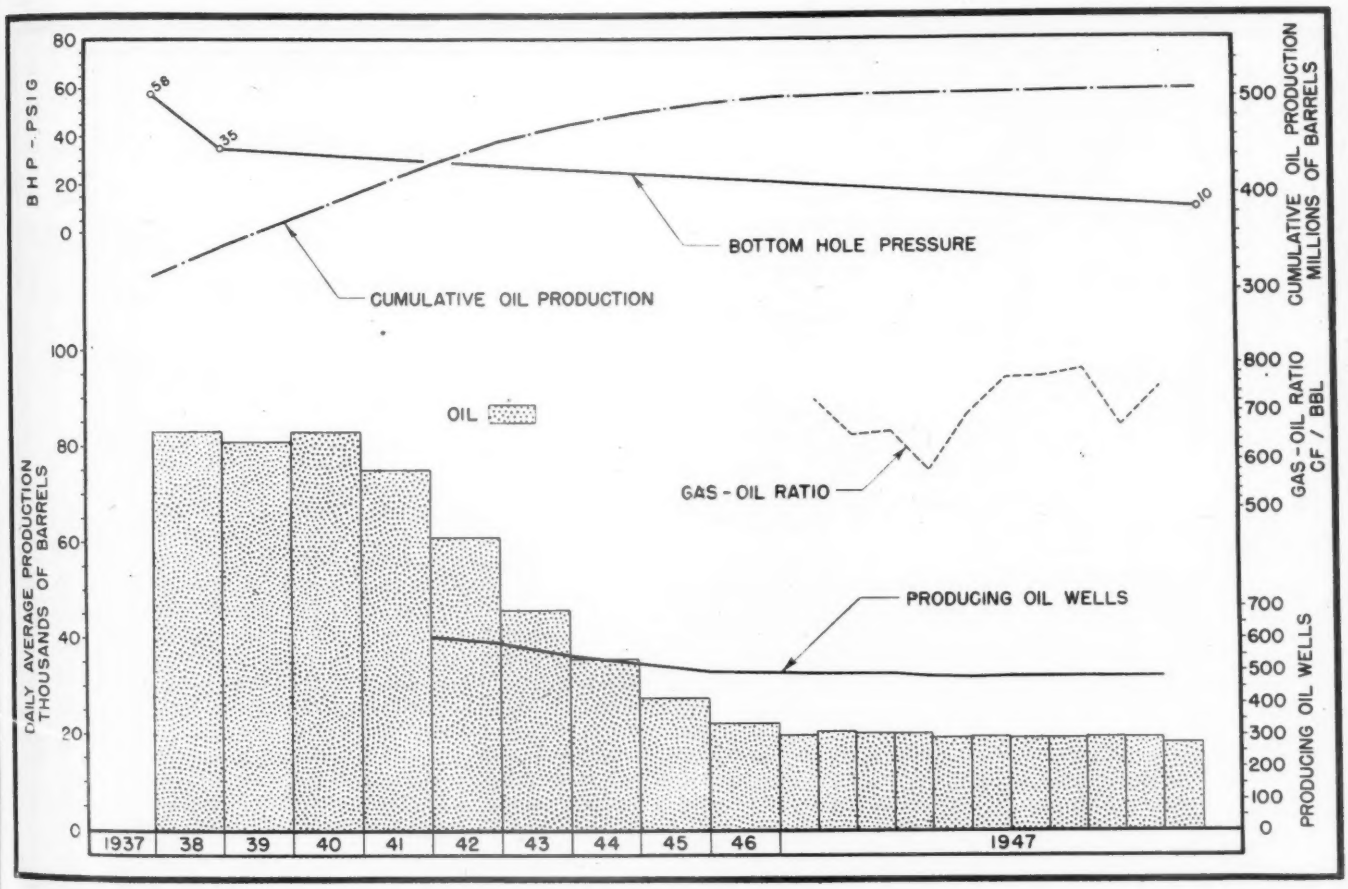
Date	Producing oil wells	Bottom hole pressure	Gas/oil ratio (CF/bbl)	Cumulative		Daily average	
				Oil (M bbl)	Gas (MMCF)	Oil (M bbl)	Gas (MMCF)
January 1947	79	3,991	983	3,069.7	3,018.4	17.7	17.4
February	86	3,985	970	3,621.3	3,553.2	19.7	19.1
March	91	3,963	969	4,263.0	4,194.9	20.7	20.1
April	99	3,961	969	4,971.0	4,902.9	23.6	22.9
May	102	3,927	1,059	5,773.9	5,752.3	25.9	27.4
June	109	3,912	1,049	6,682.9	6,706.0	30.3	31.8
July	113	3,909	1,047	7,696.6	7,766.5	32.7	34.2
August	120	3,881	1,041	8,790.9	8,904.2	35.3	36.7
September	125	3,827	1,039	9,909.9	10,068.2	37.3	38.8
October	131	3,793	1,038	11,091.0	11,292.7	38.1	39.5
November	132	3,789	1,038	12,285.0	12,531.7	39.8	41.3
December	136	3,799	1,037				

Source: Shell Oil Company.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

OKLAHOMA CITY WILCOX

Location —Oklahoma City, Oklahoma
Type of structure —Truncated Anticline
Producing formation —Wilcox
Discovery well —I.T.I.O. No. 1 Mary Sudik, March 26, 1930
Current spacing pattern— —Average elevation—1,250'
Original water level (subsea)— —Current water level (subsea)
Top of porosity (subsea)— —Effective section—
Bottom hole temperature—132° F Average porosity—23 Permeability—
Connate water—1 per cent Form volume factor—1.36 Recovery factor—
Gravity of oil—39.0 Gravity of gas— G.P.M. of gas—
Original operating GOR— —Current operating GOR
Reservoir pressure (subsea datum)— —5,260 —Original—2,686 Current—10 approximate



PRODUCTION STATISTICS

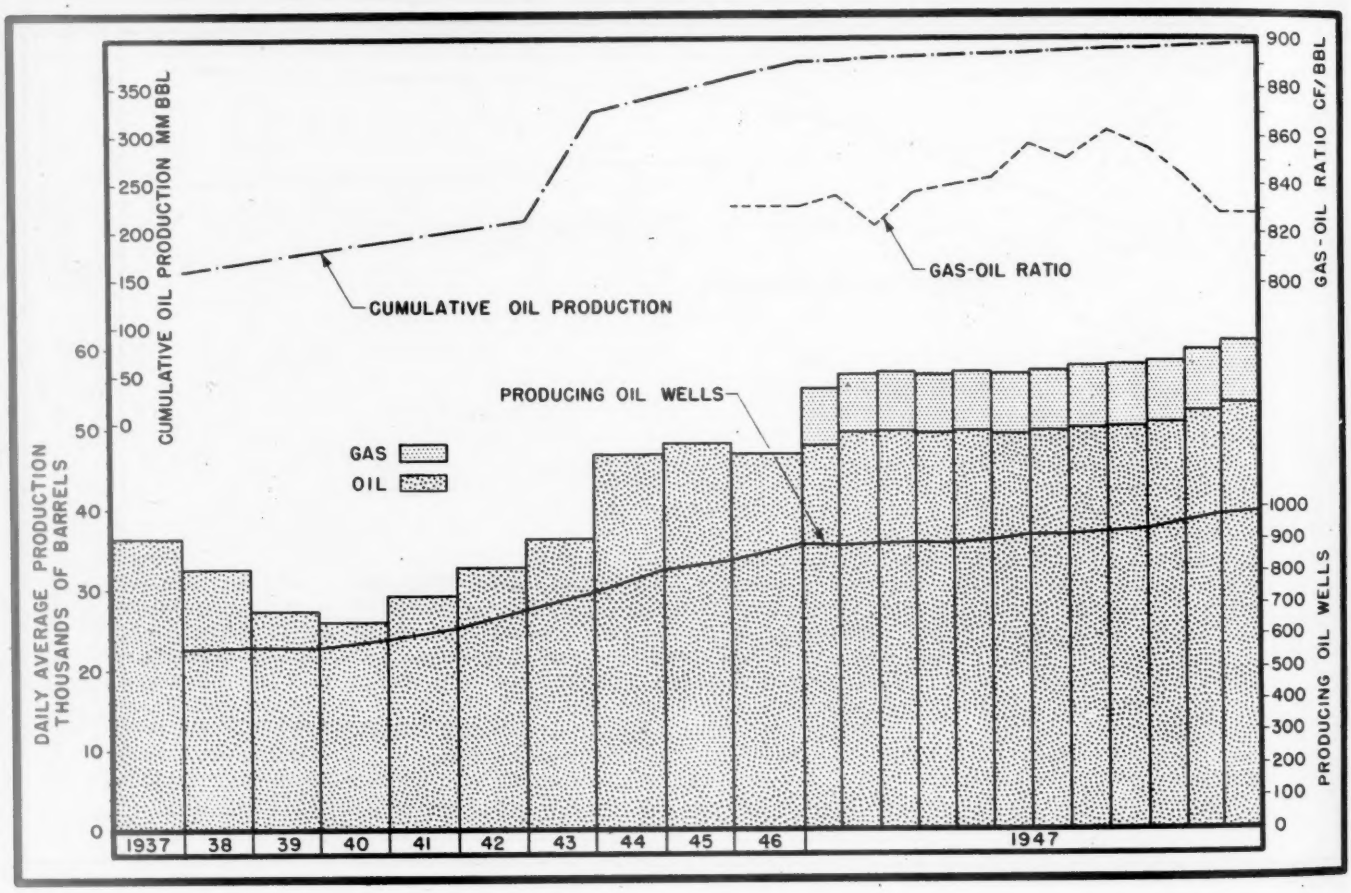
Date	Producing oil wells	Daily average production Oil (M bbl)	Cumulative production Oil (M bbl)	Date	Producing wells	Daily avg production Oil (M bbl)	Cumulative production Oil (M bbl)	GOR (CF/bbl)
1937			314,167	January 1947	491	19.85	502,778	724
1938		83.11	344,502	February	491	20.59	503,355	650
1939		81.05	374,086	March	491	20.10	503,958	658
1940		83.03	404,476	April	483	20.09	504,561	578
1941	606	75.05	431,868	May	482	19.18	505,156	691
1942	587	60.98	454,124	June	483	19.55	505,743	767
1943	550	45.87	470,868	July	483	19.21	506,339	771
1944		35.61	483,902	August	483	19.15	506,933	785
1945	498	27.70	494,014	September	483	19.56	507,520	667
1946		22.33	502,163	October	483	19.28	508,118	748
				November		18.13	508,662	
				December				

Source: Company records.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

HUNTINGTON BEACH FIELD

Location —Orange County, California
Type of structure
Producing formation —Tar, Jones, A-66, A-37, Main, Upper and Lower Ashton
Discovery well —Standard Oil Co. H. B. No. 1A
Current spacing pattern—Town lot —Average elevation—50′
Original water level (subsea)— —Current water level (subsea)—
Top of porosity (subsea)— —Effective section—
Bottom hole temperature— Average porosity— Permeability—
Connate water— Form volume factor— Recovery factor—
Gravity of oil—13°—28° API Gravity of gas— G.P.M. of gas—
Original operating GOR— —Current operating GOR—829
Reservoir pressure (subsea datum)— —Original— Current—



PRODUCTION STATISTICS

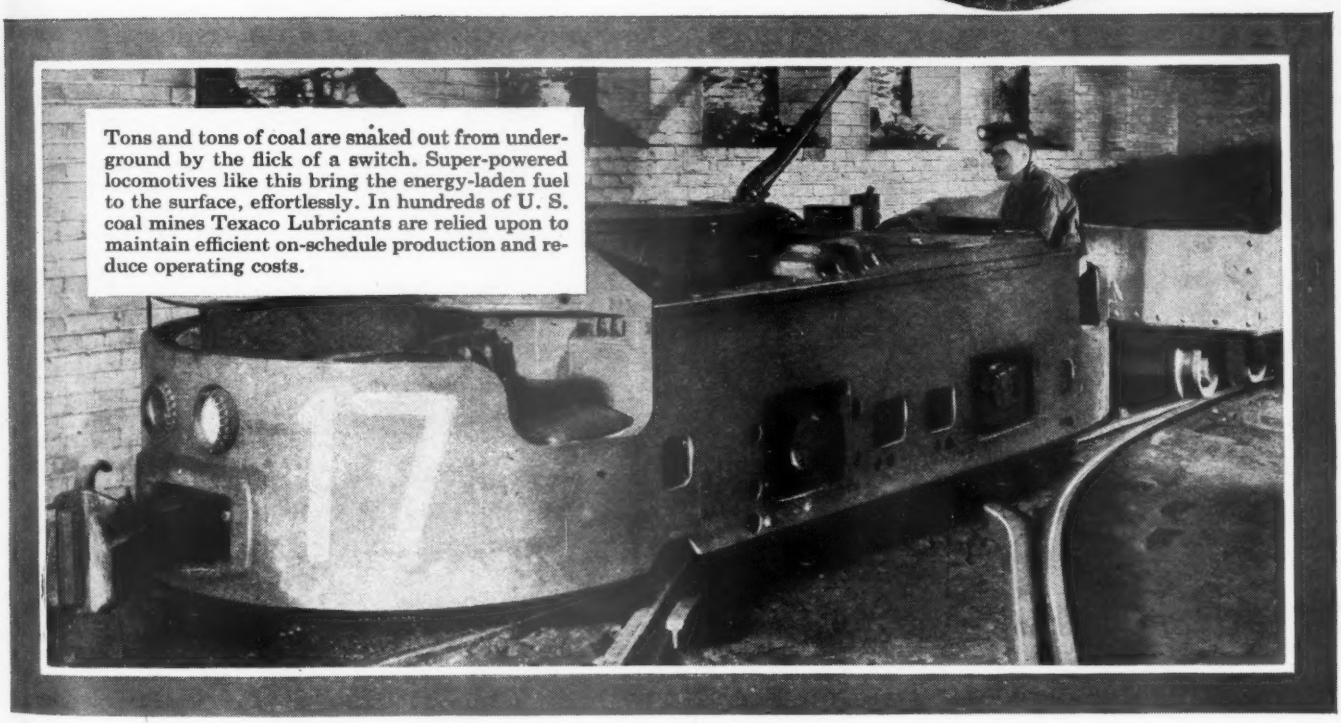
Date	Producing oil wells	Gas/oil ratio (CF/bbl)	Cumulative Oil (M bbl)	Daily average production Oil (bbl)	Daily average production Gas (MCF)	Prod water (per cent)
January 1947	884	836	379,501	47,920	40,062	
February	893	823	380,884	49,403	40,667	
March	892	837	382,423	49,662	41,583	
April	894	840	383,907	49,465	41,549	
May	900	843	385,442	49,492	41,737	40.1
June	917	857	386,925	49,447	42,390	
July	919	851	388,464	49,632	42,240	
August	929	863	390,017	50,097	43,245	
September	937	856	391,522	50,180	42,929	
October	960	844	393,095	50,747	42,666	
November	981	829	394,664	52,290	43,374	
December	984	829	396,307	53,019	43,976	40.5

Source: W. R. Wardner, Conservation Commission of California Oil Producers.

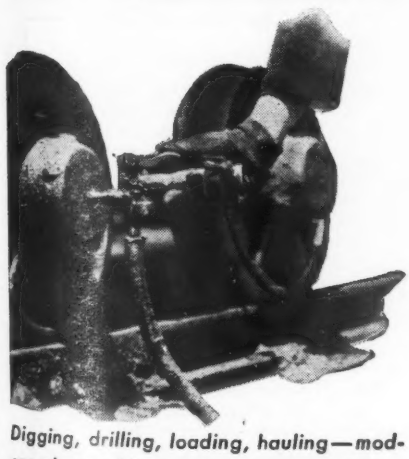
From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

$\mathcal{R}_x$ for Aching Backs

Petroleum Progress Serves the Mining Industry



Tons and tons of coal are snaked out from underground by the flick of a switch. Super-powered locomotives like this bring the energy-laden fuel to the surface, effortlessly. In hundreds of U. S. coal mines Texaco Lubricants are relied upon to maintain efficient on-schedule production and reduce operating costs.



Digging, drilling, loading, hauling—modern mine machinery stands up against abrasive dusts, dirt, heavy loads and harsh conditions—with the aid of good lubrication.

Rugged underground locomotives, loaders, shakers, cutters and other vital equipment speed the mining of coal, ease the load of the miner. Operations beneath the earth's surface are rigorous, call for heavy-duty performance. Petroleum research helped immeasurably in perfecting these machines by providing efficient lubricants. Thus petroleum lends an invaluable helping hand not only to a great industry but to the one other highly developed source of world energy.

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ing, Manoir Richelieu, Murray Bay, Quebec, Canada.

June 26-30—API, Production Division, Mid-Year Standardization Conference, Brown Palace Hotel, Denver, Colorado.

June 26-30—American Society for Testing Materials Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

August 3-5—IOCC Summer Meeting, French Lick Springs Hotel, French Lick, Indiana.

Aug. 14-16—SAE, West Coast Meeting, Biltmore Hotel, Los Angeles, Calif.

Aug. 30-Sept. 1 — Tenth Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, West Virginia.

Sept. 3-8—American Chemical Society, Chicago, Illinois.

Sept. 5-9—National Chemical Exposition, Chicago Section, American Chemical Soc., Coliseum, Chicago, Ill.

Sept. 10-13—The American Institute of Chemical Engineers Regional Meeting, Minneapolis, Minnesota.

Sept. 11-13—Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 11-15—ASME Industrial Instruments and Regulators Conference with the Instrument Society of America, Municipal Auditorium, Buffalo, New York.

Sept. 13-15—National Petroleum Assn, Hotel Traymore, Atlantic City, N. J.

Sept. 14-15—Midwest Gas Assn. Gas School and Conference, Ames, Iowa.

Sept. 18-22—Instrument Conference and Exhibit, Instrument Society of America, Memorial Auditorium, Buffalo, New York.

Sept. 25-27—ASME, Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.

Oct. 1-3—IPAA, Annual Meeting, Jefferson Hotel, St. Louis, Mo.

Oct. 2-6—AGA, Annual Convention, Atlantic City, N. J.

Oct. 2-6—Mid-Continent Oil and Gas Assn, Louisiana-Arkansas division, The Roosevelt Hotel (tentative), New Orleans, La.

Oct. 4-5—Mid-Continent Oil and Gas Assn, Texas Division, Baker Hotel (tentative), Dallas, Texas.

Oct. 9-10—American Assn of Oilwell Drilling Contractors, Annual Meeting, The Mayo, Tulsa, Okla.

Oct. 23-27—AIEE, Fall General Meeting, Skirvin Hotel and Skirvin Tower Hotel, Oklahoma City, Okla.

Nov. 9-10—SAE, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

Nov. 13-16—API, Annual Meeting, Biltmore, Hotel and Ambassador Hotel, Los Angeles, Calif.

1951

May 28-June 6 — World Petroleum Congress, The Netherlands, The Hague.

NOMADS MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Sec. Russ V. McIntire, 11 West 42nd Street, New York 18, New York.

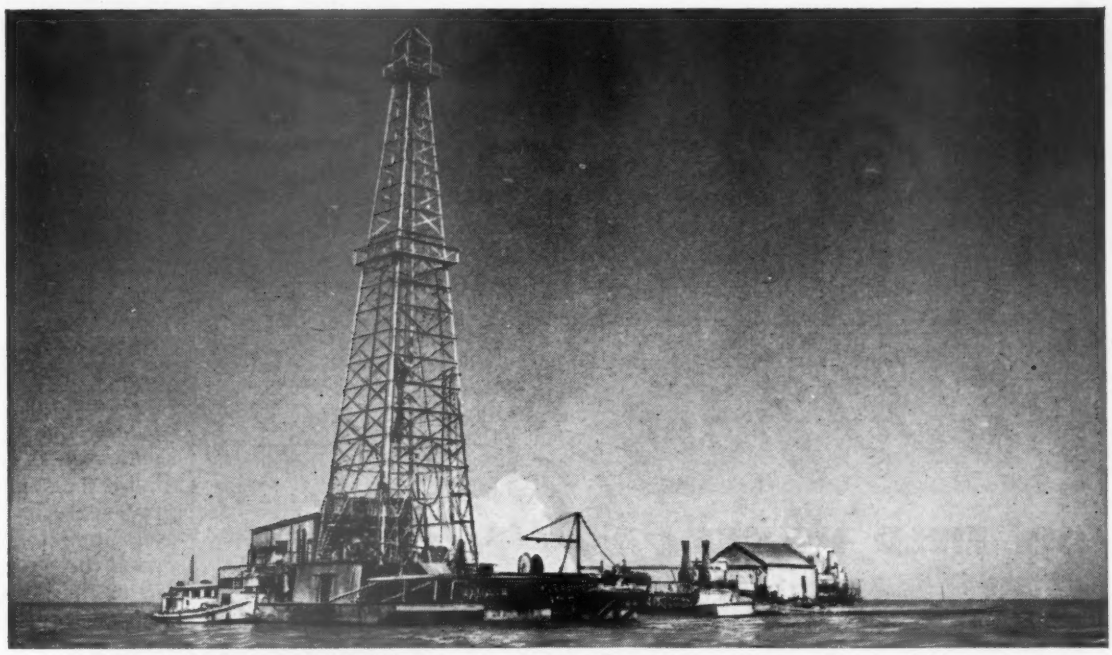
Houston Chapter, Second Monday of the Month, Ye Ole College Inn, Houston, Texas. Sec. Harry E. Estes, P. O. Box 9321, Houston 11, Texas.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Sec. John W. Rife, 5905 Pacific Blvd., Huntington Park, Calif.

Tulsa Chapter, Third Wednesday of the Month, Hotel Tulsa, Tulsa, Okla. Sec. G. W. Davidson, Jr., Box 1188, Tulsa, Okla.

Dallas Chapter, Dallas, Texas, First Monday of the month. Sec. C. J. Berlin, P. O. Box 2968, Dallas, Texas.

DEPENDABILITY THROUGH



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RESEARCH AND ENGINEERING

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LETTERS
to the Editors

Now You See Two

To The Petroleum Engineer:

I am thoroughly confused!

Until February 1950, I have been receiving "The Petroleum Engineer—Pipe Line and Marine Transportation" publication through the Stanolind Pipe Line Company. The February issue of "The Petroleum Engineer" came to me with the following title "The Petroleum Engineer—Oil and Gas Pipelining".

About a week ago we received a business reply envelope from the Petroleum Engineer, asking us to enclose $1.00 for 13 issues or $2.00 for 39 issues to "The Petroleum Engineer—Oil and Gas Pipelining".

Today, we received another business reply envelope with a letter. This envelope asks us to enclose $1.00 for 13 issues or $2.00 for 39 issues to "The Petroleum Engineer—Pipe Line and Marine Transportation." The letter said "just drop a buck in the envelope enclosed, and The Petroleum Engineer's new Oil and Gas Pipelining magazine will be running into your hands for a whole year." I have a subscription to "The Petroleum Engineer—Pipe Line and Marine Transportation" which was renewed by our letter dated October 26, 1949, but as far as I know I do not have a subscription to "The Petroleum Engineer—Oil and Gas Pipelining."

What I want to know is—Are there two Petroleum Engineer magazines—one called "Pipe Line and Marine Transportation" and one called "Oil and Gas Pipelining" or has the name been changed from "Pipe Line and Marine Transportation" to "Oil and Gas Pipelining?" If there *are* two magazines, I will send my subscription in for the "Oil and Gas Pipeling" magazine as soon as I hear from you but if the name has just been changed, my subscription, which was sent in during October 1949, should still be good for the magazine under the new name, and I shall disregard the two business reply envelopes which I received.

A. H. Newberg,
Chief Engineer
Stanolind Pipe Line Company,
Tulsa, Oklahoma.

Editor's Note: *To Mr Newberg our sincere apologies for his natural confusion. Last month we decided that the name "Oil and Gas Pipelining" was more suitable for the contents and objectives of our pipe line edition than the name "Pipe Line and Marine Transportation."*

Since our new "selective" publishing plan was introduced, PE has undergone the readjustments common to most progressive endeavor. But so far as edition titles are concerned, we believe we can promise you a reasonable assurance of permanence with those now in effect.

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Gas By-Products

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THE Petroleum Engineer

APRIL, 1950

Volume XXII No. 4

Exploration Costs Six Times Pre-War

Capital plow-back that took nearly one-third of producers' 1949 income found huge new reserves

H. J. STRUTH*

More than one and a quarter billion was spent by oil producers in the United States last year in the search for new sources of oil supply. This was six times as much as the industry spent annually for exploration between the years 1935 and 1939. The money spent for exploration in 1949 comprised a plow-back of capital, which was equal to 31.4 per cent of the total value of all the oil produced and credited to the producers' accounts during the year.

Despite rising costs of drilling and exploration, the oil industry in the United States drilled the greatest number of exploratory wells in its history, and opened to development the largest quantity of new reserves initially discovered in the last 15 years. Analysis of reserves discoveries reported for the year 1949 by the joint Committees on Reserves of the American Petroleum Institute and The American Gas Association, indicates that the combined discoveries of petroleum liquids through new fields and extensions was in the order of 2,798,000,000 bbl. This marked an increase over 1948 of 528,000,000 bbl, and established the highest rate of new oil discoveries in the last 15 years. While revisions in previous estimates reported by these committees were smaller than in 1948, by over one billion bbl, the net gain in the nation's liquid petroleum reserves in 1949, after a production of nearly two billion bbl, was about 1,578,000,000 bbl. As a result, the nation's proved reserves of petroleum liquids at the close of 1949 rose to a new peak of approximately 26,864,000,000 bbl.

*Petroleum Consultant, Dallas, Texas.

Cost Per Barrel Smaller

A substantial increase in initial reserves discoveries in 1949 resulted in a moderate reduction in finding cost per bbl. Although exploration expenditures rose to a new high record of $1,255,367,000 in 1949, the gain in quantity of initial reserves found reduced the initial finding cost per bbl to 52.5 cents, compared with an initial cost in 1948 of 58.5 cents per bbl. While the oil industry drilled 14,025 exploratory wells and dry holes in 1949, the greatest number ever drilled, the cost per well rose to a new high level of $89,509. Details of these figures are presented in Table 1.

New studies of the cost of finding oil by wildcat drilling indicate that the average initial cost per bbl during the last three years was $1.025. In 1949, the cost per bbl of oil found in new fields was reduced to $.751, due to the substantial increase in quantity of new oil discovered. In 1948, however, the cost per bbl was about $1.491, compared with an average cost in 1947 of $1.132 per bbl. These costs are only for locating the oil in place, and do not include the costs incurred by development of a new field, nor do they include the costs involved in bringing the oil to the surface.

Experience proves that after a new

EXCLUSIVE

TABLE 1. 1949 petroleum exploration expenditures.

(Preliminary estimates)

	Total cost	Cost per bbl net working interest
Drilling cost	$ 696,622,000	.291
Cost of carrying leases	378,430,000	.158
Geological, geophysical and land dept.	97,955,000	.042
Overhead and general office	82,360,000	.034
Total	$1,255,367,000	.525
Exploratory wells drilled*	14,025	
Drilling cost per well†	$49,670	
Total cost per well	$89,509	
New reserves discovered	Bbl	
New fields and new pays	983,000,000	
Extensions to previous discoveries	1,815,000,000	
Total discoveries	2,798,000,000	
Working interest (85.5%)	2,392,000,000	
Initial finding cost	$.525	

* Includes wildcat oil producers and all dry holes drilled exclusive of input wells.
† Includes cost of equipment.

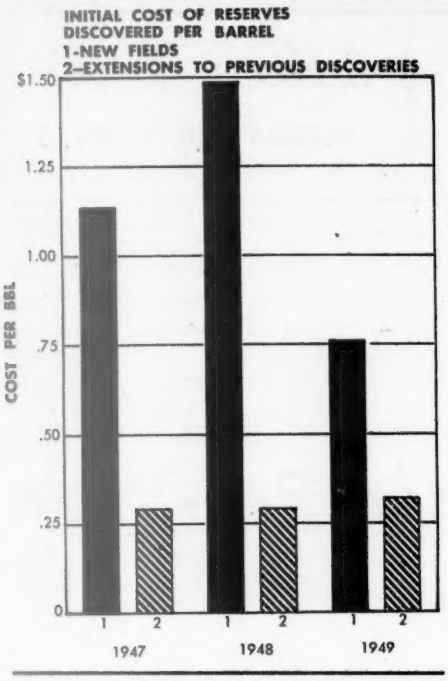


FIG. 1

oil field is discovered, the resultant efforts to extend the productive limits of the favorable oil producing area are far more successful, and usually yield substantially greater quantities of reserves than are obtained by the initial discovery effort. Studies of results obtained by extension drilling during the last three years show, for example, that reserves discoveries credited to original field discoveries were over two and one-half times as much as the initial credits. In the last three years, the cost of the oil added to original discoveries by extension drilling has averaged about 30.1 cents per bbl. In 1949, the average cost was about 31.6 cents per bbl. These costs are subsequently increased by development drilling, which results in many additional dry holes. These costs also do not include the cost of production, which involves operating and overhead charges. (See Fig. 1 and Table 2)

Today's high cost figures tend to de-glamorize the American wildcatter. In bygone days, the wildcatter was often depicted as a colorful character who played "hunches" and, with relatively little capital, struck it rich by drilling an oil well where the "experts" said there wasn't any oil. Today, the wildcatter has to be rich, even before he finds any oil, because the costs involved are tremendous and the capital risks are not particularly attractive to the casual investor. In fact, it takes not only a great deal of capital to find an oil field, but it takes a lot of scientific know-how, be-

TABLE 2. Initial finding cost—oil discovered in new fields.

	1947	1948	1949 (P)	Total 3 years
New oil found (mill bbl)	505	461	983	1,949
Working interest (85.5%)	432	394	840	1,666
Discovery wells drilled	660	783	880	2,323
Dry holes drilled	3,750	4,437	4,635	12,822
Total wells drilled	4,410	5,220	5,515	15,145
Drilling cost (thous)	$330,750	$391,500	$424,655	$1,146,905
Equipment cost (thous)	44,110	52,200	55,150	151,450
Cost of leases, geol. and geophysical, overhead, etc.	114,034	143,881	150,860	408,775
Total cost	$488,884	$587,581	$630,665	$1,707,130
Initial cost per bbl	$1.132	$1.491	$ .751	$1.025
Initial finding cost — oil discovered by extensions				
New oil found (mill bbl)	1,387	1,809	1,815	5,011
Working interest (85.5%)	1,186	1,547	1,552	4,285
Discovery wells drilled	142	177	233	552
Dry holes drilled	442	663	921	2,026
Total wells drilled	584	840	1,154	2,578
Drilling cost (thous)	$35,160	$50,400	$71,550	$157,110
Equipment cost (thous)	5,840	8,400	11,540	25,780
Cost of leases, geol. and geophysical, overhead, etc. (thous)	$308,316	$389,020	$407,885	$1,105,221
Total cost*	$349,316	$447,820	$490,975	$1,288,111
Initial cost per bbl	$.295	$289	$316	$.301

* Does not include cost of drilling development dry holes.

TABLE 3. Cost of exploration and finding cost of new reserves in the United States.

Annual data	Millions of bbl: Initial reserves found (1)	Working interest (85.5%) (2)	Revised reserves found (3)	Working interest (85.5%) (4)	Exploratory wells and dry holes drilled (5)	Thous dollars: Drilling cost (6)	Lease and overhead (7)	Total cost (8)	Cost per bbl, cents: Initial cost (9)	Revised cost (10)	Cost per well: Drilling (11)	Total (12)
1944	1,243	1,063	2,085	1,783	7,503	$240,479	$277,180	$ 517,659	48.7	29.0	$32,051	$68,994
1945	1,581	1,352	2,490	2,129	8,187	365,557	365,650	731,207	54.1	34.3	44,650	89,313
1946	1,635	1,398	2,345	2,005	9,403	420,386	405,800	826,186	59.1	41.2	44,708	87,864
1947	1,892	1,618	2,671	2,284	10,401	481,982	422,350	904,332	55.9	39.6	46,340	86,947
1948	2,270	1,941	2,523	2,157	12,850	602,575	532,901	1,135,476	58.5	52.6	46,890	88,364
1949 (P)	2,798	2,392	.....	.....	14,025	696,622	558,745	1,255,367	52.5	....	49,670	89,505
3-year moving averages												
1935–37	1,637	1,449	2,431	2,078	5,760	67,318	120,330	187,648	13.0	9.0	11,687	32,578
1936–38	1,848	1,635	2,662	2,276	6,161	75,277	132,624	207,901	12.7	9.1	12,218	33,745
1937–39	1,744	1,543	2,480	2,120	6,525	83,779	147,834	231,613	15.0	10.9	12,840	35,496
1938–40	1,441	1,275	2,311	1,976	6,607	88,836	157,154	245,990	19.3	12.4	13,446	37,232
1939–41	1,150	1,018	2,040	1,744	6,969	101,696	170,820	272,516	26.8	15.6	14,593	39,104
1940–42	919	813	1,844	1,577	6,750	111,351	173,519	284,870	35.0	18.1	16,496	42,303
1941–43	876	775	1,701	1,454	6,679	133,644	196,696	330,340	42.6	22.7	20,010	49,459
1942–44	964	853	1,801	1,540	6,717	174,083	228,890	402,973	47.2	26.2	25,917	59,993
1943–45	1,231	1,089	2,108	1,802	7,464	257,027	295,820	552,847	50.8	30.7	34,435	74,068
1944–46	1,486	1,315	2,307	1,972	8,364	342,141	349,543	691,684	52.6	35.1	40,906	82,698
1945–47	1,702	1,506	2,502	2,139	9,330	422,642	397,933	820,575	54.5	38.4	45,299	87,950
1946–48	1,932	1,652	2,512	2,148	10,885	501,647	453,683	955,331	57.8	44.5	46,086	87,765
1947–49 (P)	2,320	1,984	.....	.....	12,425	593,726	504,665	1,098,391	55.4	....	47,785	88,402

(1) Oil found in New Fields and extensions to previous discoveries.
(3) Revisions in previous estimates allocated to discovery years.
(5) Wildcat oil producers and all dry holes drilled in exploration and development, excluding service or input wells.
(6) Includes cost of equipment.
(7) Covers cost of carrying leases, geological, geophysical, land departments, general office and overhead costs.
(9) Column 8 divided by column 2.
(10) Column 8 divided by column 4.
(11) Column 6 divided by column 5.
(12) Column 8 divided by column 5.

TABLE 4. Cost of exploration vs. value of crude oil production.

	Gross crude prod. (thous bbl)	Working interest (85.5%) (thous bbl)	Average price per bbl	Value of working interest (thous $)	Cost of exploration (thous $)	Exploration Cost in per cent of oil value
1935	996,596	852,090	$ .97	$ 826,527	$ 161,313	19.5
1936	1,099,687	940,232	1.09	1,024,853	175,677	17.1
1937	1,279,160	1,093,682	1.17	1,279,608	234,795	18.3
1938	1,214,355	1,038,274	1.14	1,183,632	222,546	18.8
1939	1,264,962	1,081,543	1.04	1,124,805	249,331	22.2
5 yrs	5,854,760	5,005,821	1.08	5,439,425	1,043,662	19.2
1940	1,353,214	1,156,998	1.02	1,180,138	281,582	23.9
1941	1,402,228	1,198,905	1.14	1,366,752	305,327	22.3
1942	1,386,645	1,185,581	1.20	1,422,697	290,032	20.4
1943	1,505,613	1,287,299	1.20	1,544,759	417,649	27.0
1944	1,677,904	1,434,608	1.20	1,721,530	517,659	30.1
5 yrs	7,325,604	6,263,391	1.15	7,235,876	1,812,249	25.0
1945	1,713,655	1,465,175	1.20	1,758,210	731,207	41.6
1946	1,733,939	1,482,518	1.39	2,060,700	826,186	40.1
1947	1,856,987	1,587,724	1.92	3,048,430	904,332	29.7
1948	2,020,185	1,727,258	2.59	4,473,598	1,135,476	25.4
1949	1,840,307	1,573,462	2.54	3,996,593	1,255,367	31.4
5 yrs	9,165,073	7,816,137	1.67	15,337,531	4,852,568	31.6
Total 15 yrs	22,345,437	19,105,349	$1.47	$28,012,832	$7,708,479	27.5

cause oil is not only harder to find but is being found today at far greater depths than in bygone days. Experience of the last three years reveals the fact that the average wildcat well involves an investment for drilling, leasing, geological, geophysical, and overhead amounting to about $160,000. Since only one out of every five wildcat wells drilled is productive of oil, the total cost involved in finding that one wildcat oil producer is about $800,000.

Replacement Costs Up Sharply

Replacement costs of the nation's petroleum reserves have increased fivefold since the pre-war years. The facts prove that it is now costing the oil industry $5.00 to replace oil produced from reserves discovered previously, which cost $1.00. In fact, it now takes six times as much capital to explore for new oil fields as it did in pre-war years. A study of exploration expenditures indicates that the average annual expenditures during 1935-39 were about $208,000,000, whereas in 1949 the industry spent $1,255,367,000. Figures presented in Table 3 emphasize the rising cost of finding oil, and the growing capital requirements involved in exploratory activities. This study combines all costs of exploration, and shows the initial cost per bbl of finding oil as well as the revised cost, which embraces the annual revisions in previous estimates. The initial cost of finding a bbl of new reserves in 1949 was about 52.5 cents. The moderate reduction from 1948 was due to a substantial increase in new reserves discovered. The average initial cost of the last three years was 55.4 cents. Of particular significance is the fact that the total cost per well, including all dry holes, rose to an average of $89,509, which is the highest cost on record. (See Fig. 2) These costs and expenditures cover only those involved in exploration, and do not include costs of development of oil fields, nor the cost of producing oil.

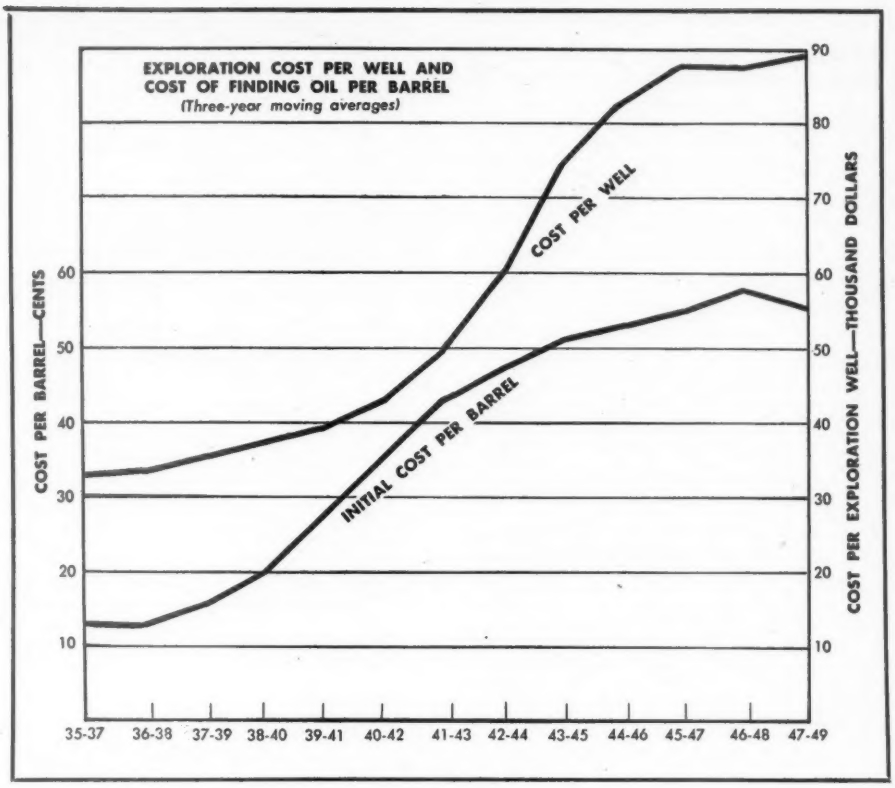


FIG. 2

While the cost of drilling exploratory wells in 1949 aggregated $696,622,000, it is estimated that the total cost of all drilling was about $1,406,902,000. This covers the total cost of 37,701 wells, and makes the combined average cost of drilling all wells, exclusive of input wells, about $37,000 each. Development wells are less costly than wildcats, which accounts for the marked differences in costs. In 1949, the average cost of drilling a wildcat, exclusive of charges for exploration, lease costs, and overhead, was about $85,000. This included the cost of equipment. By comparison, the cost of drilling extension wells was about $70,000, and the average cost of drilling development wells was about $37,000. Some wells, particularly deep tests, cost a million dollars or more to drill. Costs of drilling increase in an ascending ratio with depth, which accounts for the extremely high costs involved in drilling to depths of 12,000 ft or more.

Costs of exploration during the last five years provide a sound reason why the oil industry needs the depletion allowance of 27½ per cent. During this period, the aggregate capital investments in exploration have constituted 31.6 per cent of the total

FIG. 3

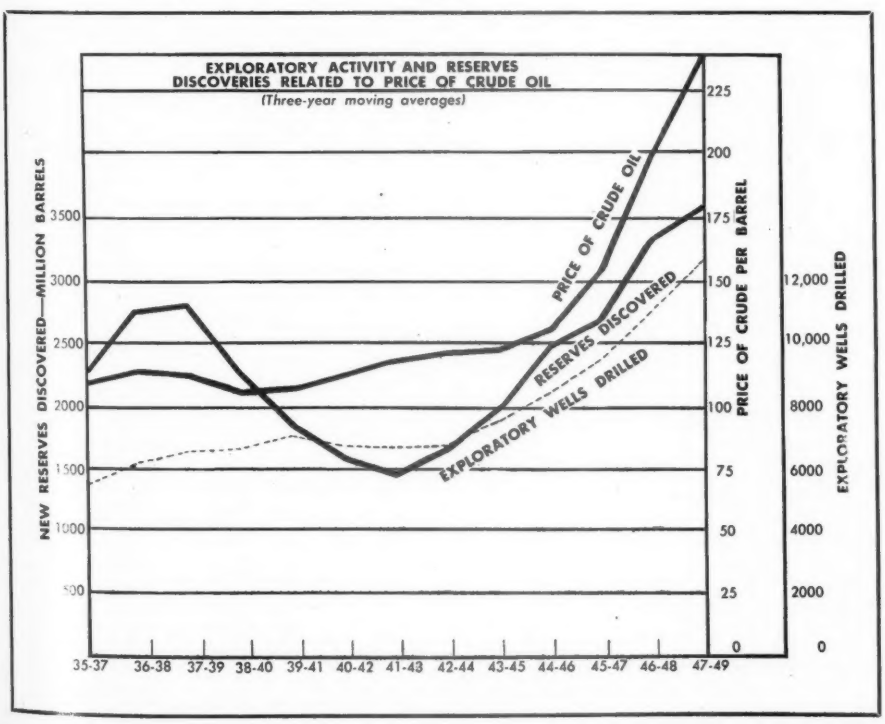


TABLE 5. Exploratory wells drilled, price of crude oil, and new reserves found.

(3-Year moving averages)

	Exploratory wells drilled (1)	Average price of crude oil (at wells) (2)	New reserves found (mill bbl) (3)
1935–37	5,760	$1.08	2,220
1936–38	6,161	1.13	2,731
1937–39	6,525	1.11	2,794
1938–40	6,607	1.05	2,248
1939–41	6,969	1.06	1,807
1940–42	6,750	1.11	1,509
1941–43	6,679	1.17	1,442
1942–44	6,717	1.20	1,629
1943–45	7,464	1.21	1,922
1944–46	8,364	1.28	2,425
1945–47	9,330	1.52	2,634
1946–48	10,885	1.97	3,286
1947–49	12,425	2.35	3,518

(1) Includes successful wildcat wells and all dry holes drilled in exploration and development, exclusive of service or input wells.
(3) Includes all reserves credited to discoveries through new fields, extensions to old fields and revisions in previous estimates.

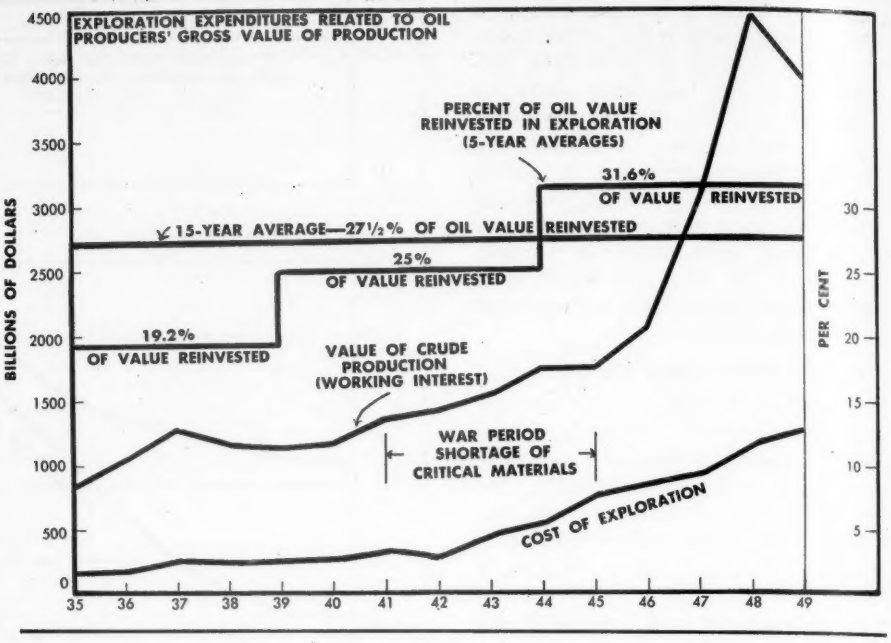


FIG. 4

value of the working interest production of crude oil. During this period, the industry spent in the United States for exploration the sum of $4,852,568,000, whereas the value of all oil produced during the period, which was credited to the producers' working interest, amounted to $15,337,531,000. The record, as shown in Table 4, reveals the fact that over a period of 15 years, the aggregate amount of capital invested in exploration amounted to $7,708,479,000, while the producers' value of oil produced amounted to $28,012,832,000. This shows that the expenditures for exploration have comprised 27½ per cent of the producers' gross income from oil production. (See Fig. 4) Today, exploration expenditures comprise nearly one-third of the oil producers' gross income, and in 1945 and 1946 these expenditures were well over 40 per cent of the oil value.

The price of crude oil has proved to be a highly important factor in the search for new sources of oil supply. When oil prices were pegged, during the war years, the number of exploratory wells drilled remained at an almost constant level. When price controls were lifted, however, exploratory activity turned sharply upward and was accompanied by increased expenditures and greatly improved results in the discovery of new reserves. (See Table 5.) Another factor that restricted exploratory activities during the war years, was a severe shortage of critical materials. This situation not only affected the course of exploration, but also constricted the flow of capital into leasing and exploratory activities. It is of particular interest to note that during the war years, when oil prices were pegged at an average of $1.15 per bbl, and

FIG. 5

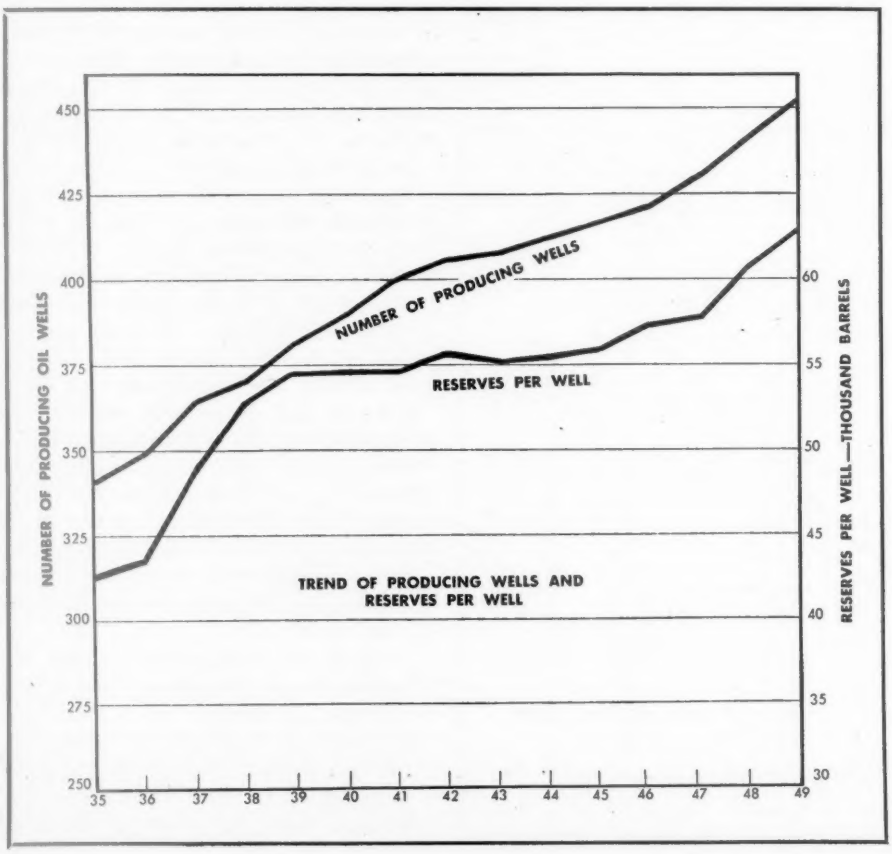


TABLE 6. Reserves per producing well in the United States.

	Number of producing wells (end of yr)	Total proved reserves of petroleum liquids (mill bbl)	Reserves per well (bbl)
1935	340,990	14,492	42,500
1936	349,450	15,160	43,380
1937	363,030	17,622	48,540
1938	369,640	19,507	52,770
1939	380,390	20,690	54,390
1940	389,010	21,281	54,700
1941	399,960	21,873	54,690
1942	404,840	22,383	55,290
1943	407,170	22,399	55,010
1944	412,220	22,710	55,090
1945	415,750	23,194	55,790
1946	421,460	24,037	57,030
1947	429,637	24,765	57,640
1948	441,895	26,870	60,800
1949 (p)	451,770	28,442	62,957

TABLE 7. United States petroleum reserves situation.

(Crude oil and natural gas liquids) (e)
Millions of barrels

	Proved reserves beg. of yr	Original discoveries through new fields and new pools	Extensions and revisions	Total reserves added	Production	Net addition to reserves	Allocation of extensions and revisions*	Ultimate reserves credited to original discoveries	Adjusted reserves end of yr.	Ratio ultimate reserves credits to original discoveries
1935.....	14,243	955	330	1,285	1,036	249	1,620	2,575	19,506	2.70
1936.....	14,492	860	950	1,810	1,142	668	1,988	2,848	21,212	3.31
1937.....	15,160	940	2,850	3,790	1,328	2,462	1,878	2,818	22,702	3.00
1938.....	17,622	825	2,325	3,150	1,265	1,885	2,373	3,198	24,635	3.88
1939.....	19,507	360	2,140	2,500	1,317	1,183	2,042	2,402	25,720	6.67
1940.....	20,690	315	1,685	2,000	1,409	591	2,162	2,477	26,788	7.86
1941.....	21,281	455	1,620	2,075	1,483	592	1,907	2,362	27,667	5.19
1942.....	21,873	280	1,700	1,980	1,470	510	1,846	2,126	28,323	7.59
1943.....	22,383	345	1,265	1,610	1,594	16	1,943	2,288	29,017	6.63
1944.....	22,399	515	1,574	2,089	1,778	311	1,940	2,455	29,694	4.77
1945.....	22,710	440	1,870	2,310	2,693	1,850	1,926	2,366	30,234	5.38
1946.....	23,194	323	2,370	2,693	1,850	843	1,499	1,822	30,206	5.64
1947.....	24,037	505	2,211	2,716	1,988	728	1,318	1,823	30,041	3.60
1948.....	24,765	461	3,805	4,266	2,167	2,099	511	972	28,846	2.11
1949(p)....	26,864	983	2,592	3,575	1,997	1,578	610	1,593†	28,442	1.62
1950(p)....	28,442	....	....	....	....	....	....	....	.....	....
Totals...	14,243	8,562	29,287	37,849	23,650	14,199	25,563	34,125	28,442	3.99‡

(e) Discoveries adjusted for years prior to 1947 to include natural gas liquids, which have been estimated by the author.
* Subject to subsequent upward revisions.
† To balance estimated end of year reserves.
‡ Median, 8 years — 1941–48 — is in the ratio of 5.28 times original discoveries.

when materials were difficult to obtain, the amount of capital released for exploration amounted to 25 per cent of the net value of oil production. However, in the last five years, when the price of oil moved up to an average of $1.67 per bbl, the industry reinvested 31.6 per cent of its net oil production value. Over the entire period of ten years, however, the average amount of capital reinvested in exploration comprised about 29 per cent of the net value of oil produced during that period.

Proved Reserves Per Well Rise

Highly important to the security of the United States is the fact that the quantity of proved reserves per well has shown a consistent increase during the last 15 years. During this period, the number of producing wells has increased 32 per cent, while the quantity of proved reserves per well has increased 50 per cent. Meanwhile, the nation's available reserves of petroleum liquids have doubled. Estimates place the number of producing oil wells in the United States, at the close of 1949, at approximately 451,770. (See Table 6 Fig. 5.) With proved reserves estimated at 28,442,000,000 bbl at the close of the year, this means that each producing oil well in the United States represents a proved reserve supply of about 62,957 bbl. In 1935, the average quantity of reserves per well amounted to about 42,500 bbl. This upward trend is indicative of the highly successful efforts of American oil producers to provide the public and the nation with adequate supplies of oil in response to growing requirements.

The position of the United States with respect to future availability of petroleum liquids reserves is far better than many persons realize. That position emphatically denies unfounded, repetitious fears that the nation is faced with an oil shortage. The facts prove definitely that the United States not only has the largest proved reserves of petroleum in its history, but that these reserves do not by any means represent all of the oil in sight for available consumption. A careful study of trends in secondary exploration, following initial new field discoveries, reveals the fact that the ultimate reserves credited to original oil field discoveries comprise about five times the quantities estimated to have been found through original discoveries. During the eight years prior to 1949, for example, initial discoveries of oil in new fields aggregated 3,324,000,000 bbl. However, subsequent exploration by extension drilling increased the ultimate reserves credited to original discoveries to a total reserves credit of 16,214,000,000 bbl, or about five times the quantity found by original discoveries. (See Table 7.) The average increment in reserves credited to original discoveries over a period of 15 years has been 3.99. The median increment over the last eight years has been 5.28. During this 15-year period, additions to proved reserves by extension drilling have aggregated 25,563,000,000 bbl above the combined original discoveries of 8,562,000,000 bbl. (See Fig. 6.)

New field reserves discoveries in 1949 have been estimated at a total of 983,000,000 bbl. In the light of ex-

FIG. 6

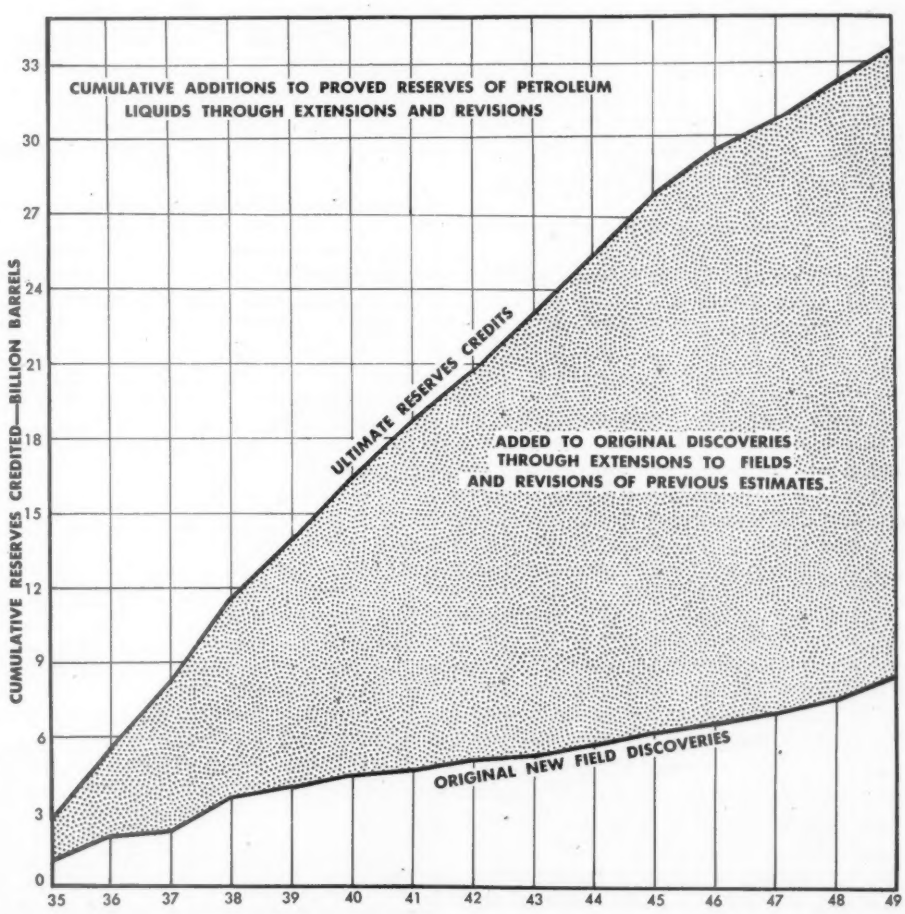


TABLE 8. Drilling and exploration results.

	1945	1946	1947	1948	1949 (P)	Total 5 years
Wildcats						
Oil wells (new disc.)	427	498	660	783	880	3,248
Oil wells (extensions)	114	141	142	177	233	807
Gas wells	130	145	207	245	203	930
Dry holes	3,434	3,831	4,192	5,100	5,556	22,113
Total	4,105	4,615	5,201	6,305	6,872	27,098
Development dry holes	4,212	4,933	5,407	6,790	7,356	28,698
Total exploratory wells	8,317	9,548	10,608	13,095	14,228	55,796
Development oil wells	13,921	14,771	17,235	21,068	20,697	87,692
Development gas wells	2,595	3,093	3,183	2,584	2,776	14,231
Total drilled for oil and gas	24,833	27,412	31,026	36,747	37,701	157,719
Input wells	2,212	2,242	2,264	2,159	1,184	10,061
Total wells drilled	27,045	29,654	33,290	38,906	38,885	167,780
New discoveries						
Oil wells completed	427	498	660	783	880	3,248
New discoveries (mill)	440	323	505	461	983	2,712
Average per well (thous)	1,030	649	765	588	1,117	835
Extensions						
Oil wells completed	114	141	142	177	233	807
New discoveries (mill)*	1,141	1,127	1,387	1,809	1,815	7,279
Average per well (thous)	10,010	7,993	9,768	10,220	7,790	9,020
Composite						
Oil wells completed	541	639	802	960	1,113	4,055
New discoveries (mill)†	1,581	1,450	1,892	2,270	2,798	9,991
Average per well (thous)	2,922	2,269	2,359	2,364	2,514	2,464
Total exploratory wells (e)	8,187	9,403	10,401	12,850	14,025	54,866
New discoveries (mill)	1,581	1,450	1,892	2,270	2,798	9,991
Average per well (thous)	193	154	182	176	200	182

* Discoveries reported by joint committees on petroleum reserves of The American Petroleum Institute and American Gas Association.
† Author's estimates.
(e) Excludes wildcat gas wells. (P) Preliminary

TABLE 9. Exploratory drilling and discoveries.

(3-Year moving averages)

	Total exploratory wells drilled	New reserves discovered* (mill bbl)	Wells drilled per mill bbl discovered	Reserves discovered per well (thous bbl)
1935–37	5,760	1,637	3.5	284
1936–38	6,161	1,848	3.3	300
1937–39	6,525	1,744	3.7	267
1938–40	6,607	1,441	4.6	218
1939–41	6,969	1,150	6.1	165
1940–42	6,750	919	7.3	136
1941–43	6,679	876	7.6	131
1942–44	6,717	964	7.0	143
1943–45	7,464	1,231	6.1	165
1944–46	8,364	1,486	5.6	178
1945–47	9,330	1,702	5.5	182
1946–48	10,885	1,932	5.6	177
1947–49	12,425	2,320	5.4	187

* New oil found in new fields and extensions to previously discovered fields.

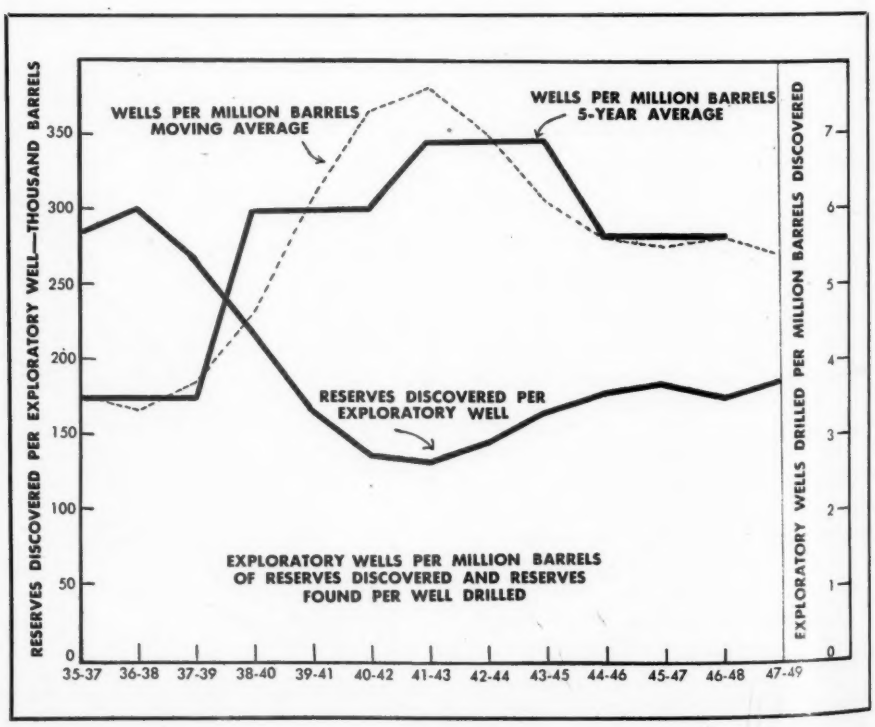
perience during the last eight years, which has resulted in ultimate discovery credits through extension drilling in the order of five time original discoveries, it is not unlikely that the initial, new field discoveries may subsequently prove to have amounted to as much as 5,000,000,000 bbl. This, of course, is predicated upon the need for intensive extension drilling, which involves additional, large expenditures of capital. This re-emphasizes the oil industry's need for the depletion allowance, which has proved to be the mainstay in encouraging secondary exploratory efforts. Discoveries in 1949 undoubtedly opened tremendous prospective reserves, that can only be proved by a continued, heavy program of extension drilling. These additional, prospective reserves can be made available to the nation, but only through huge capital expenditures. Without the depletion allowance of at least 27½ per cent, the expenditures necessary to insure their discovery might otherwise prove impossible of realization.

Through extension drilling and revisions of estimates of previous discoveries, the nation's proved reserves of petroleum liquids have been augmented to a considerable extent. While the latest estimates place the nation's proved reserves at 28.4 billion bbl, the credits built up by extensions and revisions raised the underground inventory at the close of 1945 to an ultimate total of 30.2 billion bbl. This does not imply that there has been a decline in reserves since 1945; it means that today's proved reserves are actually greater, because the new oil found in 1949 opened the way to secondary exploration that will undoubtedly implement the estimate of proved reserves at the close of 1949.

Extensions Add Most Reserves

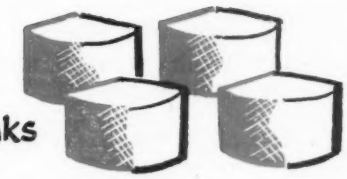
A factor of far-reaching importance to the nation's petroleum reserves situation is revealed by the results of extension exploration. During the last five years, the facts show that reserves discovered by extension drilling have amounted to 2.7 times the quantities of oil found originally in new fields. New discoveries during this period aggregated 2,712,000,000 bbl, while discoveries added by extensions totaled 7,279,000,000 bbl. The average quantity of reserves discovered per successful well drilled during this period was about 835,000 bbl. The results obtained in extension drilling per successful well during this period amounted to 9,020,000 bbl. This indicates that extension wells prove up more than 10 times as much new oil per well as new field wildcats. This, again, emphasizes the oil industry's definite need for sufficient capital for secondary exploration, which is so highly important to the national security. If the industry was deprived of the depletion allowance, or if the

FIG. 7



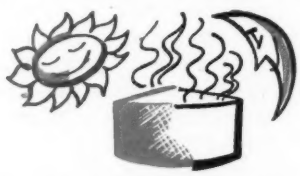
Easy Lesson in CONSERVATION ECONOMICS

If you have several cone roof tanks



that can be interconnected,

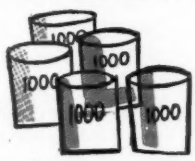
you can convert breathing losses



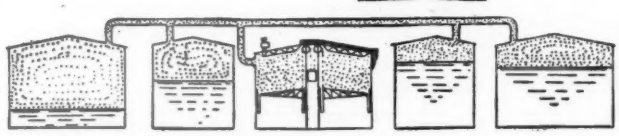
and filling losses

into profits quickly. Field studies at a typical gasoline plant

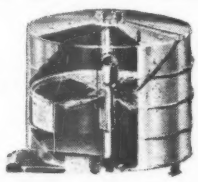
show $aving$ of more than 5,000 gallons



a week when six cone roof tanks were hooked up

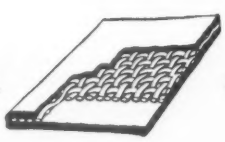


with a Wiggins DRY SEAL Gasholder.



Including expenses,

amortization took less than 20 months. What's more, the Wiggins 100% DRY SEAL



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present rate is reduced to 15 per cent, instead of 27½ per cent, it is extremely doubtful that the oil industry could afford to reinvest nearly one-third of the value of oil production in exploration. Any temporary gain in income taxes by the federal government through a reduction in the depletion allowance would undoubtedly stifle exploration and would not be in the best interests of the nation's security.

Exploratory results in 1949 were somewhat better than average. New discoveries through new fields and extensions to previously discovered fields aggregated 2,798,000,000 bbl, compared with 2,270,000,000 bbl in 1948. The number of exploratory wells drilled, including wildcat producers and all dry holes drilled, rose to a new high level of 14,228, compared with 13,095 in 1948, and only 8,317 in 1945. (See Table 7.) The average quantity of oil discovered per exploratory well in 1949 was 200,000 bbl, compared with an average per well in 1948 of 176,000 bbl. The industry drilled in 1949 the greatest number of wells in its history. While the total of all wells drilled, including service wells, was slightly lower than in 1948, the number of wells drilled for oil and gas exceeded the number drilled in any previous year. The sharp decline in the number of input, or service wells drilled last year accounted for the slight decline in all wells drilled.

Finding oil is never an easy job at best. It requires both physical and financial courage, as well as perseverance. Inasmuch as some dry holes have cost more than one million dollars, the immense job the oil industry is doing to provide the American public with ample petroleum products can be understood and appreciated.

Exploratory drilling results have been fairly consistent during the last six years. Analysis indicates that the average number of exploratory wells drilled per million bbl of oil found during this period has ranged between 5.4 and 5.6 wells per million. (See Table 9.) By employing 3-year moving averages, it is noted that the number of wells drilled per million bbl found has increased from about 3.5 wells to an average of about 5.6 wells per million since 1935. While reserves discovered per exploratory well drilled have also been fairly consistent during the last five years, it will also be noted that there has been a substantial decline in the quantity found per well, in comparison with the period 1935-40. (See Fig. 7.)

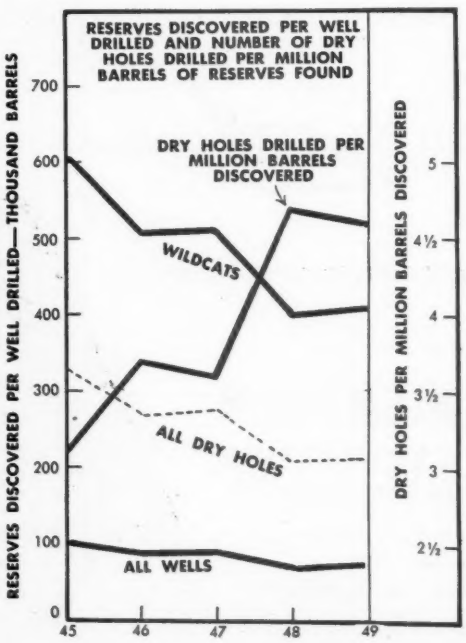
TABLE 10. Reserves discoveries related to drilling.

	Total reserves discovered* (mill bbl)	Wildcats drilled		All wells drilled‡		All dry holes drilled‡	
		Wells	Res disc per well (thous)	Wells	Res disc per well (thous)	Wells	Res disc per well (thous)
1945	2,490	4,105	607	24,833	100	7,646	326
1946	2,345	5,615	508	27,412	86	8,764	268
1947	2,671	5,201	514	31,026	86	9,599	278
1948	2,523	6,305	400	36,747	69	11,890	212
1949 (P)	2,798†	6,872	407	37,701	74	12,912	217
Totals 5 years	12,827	27,098	473	157,719	81	50,811	252

* Oil discovered in new fields and extensions to previously discovered fields, with revisions in estimates credited to original discovery years.
† Initial discoveries through new fields and extensions only. (P) Preliminary
‡ Excluding service wells.
Note: It took 4.6 dry holes to lead to the discovery of a million bbl of reserves in 1949, compared with 3.1 dry holes per million in 1945.

Oil reserves discoveries in relationship with various types of wells drilled present some highly interesting data. (See Table 10.) In the last five years, the quantity of oil discovered per wildcat well drilled averaged about 473,000 bbl. However, in 1945, the average per well was 607,000 bbl, while in 1949, the average was only 407,000 bbl. It is evident, therefore, that oil is becoming harder to find, and in consequence is far more costly than in earlier years. While dry holes are a financial loss to the industry, and are not productive of oil, they do lead to the discovery of new reserves. The experience of the last five years shows that the oil industry drilled four dry holes before it found a million bbl of new reserves. The number of dry holes drilled per million bbl of oil found in 1949 was 4.6, compared with 3.1 in 1945. Reserves found per dry hole drilled in 1949 averaged 217,000 bbl, compared with an average per dry hole drilled in 1945 of 326,000 bbl. (See Fig. 8.)

FIG. 8



In the last five years, the quantity of new reserves discovered in relationship to all wells drilled for oil and gas was at the average rate of 81,000 bbl per well. In 1949, the average per well was 74,000 bbl, which compares with an average per well in 1945 of about 100,000 bbl. Discovery totals used in this instance are the combined reserves credited to new fields and extensions to previously discovered fields, plus credits to back years of oil added by revisions in previous estimates. The reserves figures for 1949, however, include only the oil found in new fields and the oil added by extension drilling. Subsequent credits by revisions are expected to increase the rate of discovery in 1949, as well as in several prior years.

More Drilling Needed

The outlook for oil and gas well drilling in the United States, predicated upon future requirements for petroleum and its products, implies the necessity for more drilling than ever before. If the petroleum industry expects to continue to discover new oil supply sources at the rate of discoveries made in 1949, it will be necessary for the industry to drill about 41,000 wells annually. This is about 8 per cent more than the number of wells drilled in 1949. To accomplish this objective, and to insure the adequacy of the nation's future oil supply, it will be necessary for the petroleum industry to greatly increase its expenditures for exploration. This means that a greater proportion of the oil producers' gross income from oil production must be reinvested in exploration. It means that it is more than ever imperative that oil producers of the United States be granted an adequate compensatory allowance for depletion. * * *

P 967.6

Possibilities for Production of Liquid Fuels From Shale, Natural Gas, and Coal

PAUL D. TORREY*

PART 2

Coal Reserves

The reserves of coal, including lignite, in the United States are very large, and have been estimated by Hendrick[14] as shown in Table 2.

With recoveries of liquid hydrocarbons in the range of one to two barrels per ton of coal, either by the gas synthesis process or by hydrogenation, already indicated from pilot plant operations in the United States, it is apparent that the amount of liquid fuels that might be produced from the estimated coal reserves is truly stupendous. The present consumption of coal in the United States amounts to about 0.6 billion tons per year. If an equal amount of coal could be produced annually for conversion into liquid fuels, which would supply a substantial part of the domestic demand for motor fuel, the reserve of coal would still appear to be ample for both solid and liquid fuel requirements, for the predictable future.

A gas synthesis plant, having a capacity of 10,000 bbl of gasoline per day, will use at least 5000 tons of high grade bituminous coal per day, or about 50 million tons for an assumed plant life of 25 years. Using an 8-ft coal seam, an area of approximately 10 sq. miles would be mined during this period. The large tonnage of coal required for a single synthetic liquid fuel plant, therefore, will make it desirable to place the plant at the mine mouth if an abundant supply of water is available. It is believed that satisfactory plant sites may be found in several states. Some of the eastern and central states have the advantage of high quality coal, good water supplies, and accessibility to markets. The western states, in contrast, have thick coal seams, which frequently can be strip-mined at low cost, and vast reserves, chiefly on Federal lands, which could be dedicated to synthetic liquid fuel plants.

Estimations of billions of barrels of liquid fuels which may be produced from coal should not be accepted too literally, for it must be recognized that 70 per cent of the total coal reserves are west of the Mississippi River, and partly in an arid and sparsely populated region. The tremendous quantities of water required for hydrocarbon synthesis presents an immediate problem in arid regions, and might serve to retard the development of synthesis plants where water is not abundant. It is even conceivable that water resources for irrigation or for distant municipal supply might have to be abandoned in certain parts of the country if the United States ever reaches a point where it must depend on coal as the principal source of liquid fuel supply.

It is also pertinent to the subject to observe that the reliability of various estimations on the availability of coal for the production of synthetic fuels has been questioned. The estimation made by Hendrick,[14] which is believed to have been developed, with some adjustments, on studies made by the U. S. Geological Survey in 1907, is based on coal deposits within 3000 ft of the surface. For the estimation of tonnage of anthracite and bituminous coals, beds down to 14 in. in thickness were considered mineable. For subbituminous coal and lignite the minimum bed thickness considered was 24 in. and 36 in. respectively. The opinion has been expressed by some mining experts that 14-in. seams of coal at depths of 3000 ft could be removed only with great difficulty and at great expense, if at all. For this reason it is considered prudent by well informed authorities to assume a commercial production of only 50 per cent of the total coal reserve estimated in Table 2, but even with such considerable discount the reserves are still of most imposing magnitude. Likewise, since there appears to be some divergence of opinion on the availability of coal for possible synthetic fuel production, a complete reappraisal of the coal reserve situation, as advocated by the Bureau of Mines and the Geological Survey for a number of years, would seem to be a matter of national importance. Until such study can be made, the reliabiliy of all estimations of the immediate availability of coal to provide a substantial supplement to the liquid fuel requirements of the country will be subject to some question.

TABLE 2. Estimated United States coal reserves, billions of tons in place, January 1, 1937.

Location	East of Mississippi River	West of Mississippi River	Total United States
Classification			
Anthracite	15.1	0.3	15.4
Bituminous	837.5	570.3	1,407.8
Sub-bituminous		818.1	818.1
Lignite		939.5	939.5
Total	852.6	2,328.2	3,180.8

EXCLUSIVE

Costs and Possible Production of Liquid Fuels From Coal in the United States

The cost of production of gasoline from coal by the gas synthesis process, as it has been developed in Europe, has been estimated by Power[8] to be $0.192 per gallon with coal at $2.75 per ton. Later estimates by Murphree,[10] in which the results of some American experimental work are considered, indicate that high-octane gasoline can be produced by the synthesis of coal gases at a cost of $0.166 per gallon with coal at $3.20 per ton. The figures of both authorities are based on a production of about 1.25 bbl of gasoline per ton of coal. Power[8] indicates that by the development of improved methods, such as the continuous production of synthesis gas or underground gasification, it might be possible to produce gasoline in the United States at a cost of as low as $0.06 per gallon. Figures recently developed and published by Keith[9] are somewhat more optimistic than the previous statements of Power and Murphree, and indicate that premium gasoline may be produced from coal under present conditions at a net cost of $0.12 per gallon if a liberal return is assumed from the sale of by-product chemicals.

Power[8] has estimated that gasoline might be produced by the carbonization process at a cost of $0.10 per gallon, but assumes, in the development of this figure, that the coke formed in the process would be used

*President, Lynes, Inc.

subsequently in manufacture of gasoline by the gas synthesis process.

The investment required for the construction of coal hydrogenation plants is very high in comparison to modern petroleum refineries or to synthesis plants designed to use natural gas. The production cost of gasoline from coal hydrogenation plants is also high, and will probably vary according to plant size and the type of coal utilized. Recent testimony before Congressional Committees has indicated that operating cost, including depreciation, for plants using coal at $2.75 per ton would amount to from $0.155 to $0.226 per gallon depending on plant size and location. The opinion has been expressed that future research might lower production costs substantially in very large scale operations, but present information does not provide any assurance of large economies in the predictable future.

Production Costs

From the preceding discussion it appears reasonable to conclude that synthetic liquid fuels for sometime to come likely will be more supplementary to than competitive with petroleum products. As previously emphasized, gasoline might be produced by the synthesis process, using natural gas for raw material, at a cost which could be competitive with gasoline produced from crude petroleum. However, as the cost of construction of synthetic plants has increased enormously, and as the amount of natural gas which might be used for the production of synthetic fuels is definitely limited, competition from this source with either primary or secondary oil production is not regarded seriously. However, it can be foreseen, in the somewhat more distant future, competition to some extent may develop from shale oil and from plants using coal for the production of synthesis gas, or even from greatly improved hydrogenation processes.

Murphree[10] recently has made a direct comparison of probable material requirements and production costs for the maximum possible production of a very high-octane fuel, considerably above the present premium grade, from crude petroleum and from other possible sources. These cost figures are the most complete that are generally available, and are quoted in Table 3.

In Table 3 the costs of gasoline produced from crude oil and from natural gas include 5 per cent per year on the original cost for amortization and 10 per cent per year for return on the investment in the plant and transportation facilities. The costs of gasoline produced from coal and shale include 5 per cent per year for amortization and 10 per cent per year for return on investment in mining, manufacturing, and transportation facilities.

TABLE 3. Approximate cost of high-octane gasoline based on maximum gasoline production.

Raw material cost	Crude oil $2.78/B*	Natural gas $0.10/-MCF**	Coal*** $3.20/T	Oil shale $1.00/T
Gasoline cost, cents per gal				
Raw material	8.8*	2.9	3.9	4.2
Manufacturing less credits	4.3	8.9	12.7	11.8
Production transportation	1.0	1.0		
Total****	14.1	12.8	16.6	16.0
Add cost for housing if required			1.9	0.6

*Price delivered to the refinery.
**Price in field after gathering.
***In Eastern States for use in Fischer-Tropsch plants.
****Includes 15 per cent capital charges.

Effect of increase in raw material charge
For crude oil—$1.00 per bbl adds 0.032 per gal.
For natural gas—$0.10 per MCF adds 0.029 per gal.
For coal—$1.00 per ton adds 0.012 per gal.
For shale—$1.00 per ton adds 0.042 per gal.

Effect of 10% return on investment in manufacturing
For crude oil—0.016 per gal.
For natural gas—0.037 per gal.

Effect of 10% return on investment in manufacturing plus mining
For coal—0.056 per gal.
For shale—0.055 per gal.

Crude oil cost is based on the price schedule existing at the time of Murphree's study plus delivery charge to a Gulf Coast refinery. Natural gas cost has been assumed at $0.10 per 1000 cu ft in the field. Coal costs are from representative Western Pennsylvania operations and assume some improvements in mining technique.

A favorable competitive position for gasoline produced from natural gas, in comparison with gasoline produced from crude petroleum, at the costs designated for raw materials, is evident from Table No. 3. The costs of production of gasoline from coal and oil shale are greater, and the cost of production from coal would probably be substantially greater for operations west of the Mississippi River, when the raw material is abundant but is generally of inferior quality, and where transportation costs to centers of consumption will be high.

It should be recognized that figures based on other products or ranges of products might show materially different unit costs and ratios of costs. It is only fair that consideration should be given to the best possible utilization of each possible source of liquid fuel supply, and the manner in which the products may best be adapted to the national economy. Shale oil, for instance, has much better possibilities for the production of heavier heating oils rather than for the production of premium motor fuels.

Comparison of capital investment costs for the production of substitute or synthetic fuels, and for the production of refined products from crude petroleum are even more difficult to make, and depend: First, on the products that are to be manufactured; second, on the location of the plant; and, third, on the location of the product market area. As shown by Murphree,[10] for the maximum production of premium gasoline, crude petroleum at the present time (1949) has a substantial advantage over all other basic raw materials in the cost of construction of production facilities.

Summary

In any attempt to evaluate the development and operating cost of synthetic liquid fuel plants, it should be appreciated that much data are not based upon results from large scale plant operation in the United States. Cost figures have had to be projected from results obtained in the older, smaller, and less efficient European operations, and from small scale pilot plant research. Consequently, the true economic position of the synthetic fuel plants will be much easier to establish after commercial plants have been in operation for a sufficient period to permit inevitable corrections in plant design and process. Unquestionably, work now in progress by the Bureau of Mines should help to supply much needed and more reliable information on the subject of cost.

Furthermore, in comparing the cost of oil production with that of synthetic fuels it should be noted that the cost of producing oil is not constant through the life of a field, and, usually, becomes progressively more costly. The situation is somewhat different in the production of shale oil, or of synthetic liquid fuels from coal, when raw materials are available to supply plants located in regions of abundant resources in almost unlimited quantity. In all probability, such plants should be able to operate to maximum capacity until the supply of raw material is exhausted completely, and the cost per barrel of fuel produced will not increase because of any reduction in total output, an advantage which is not inherent to most oil fields.

A fact that deserves particular emphasis is that neither shale oil nor the products of gas synthesis or coal hydrogenation are the exact equivalents of petroleum or the products refined

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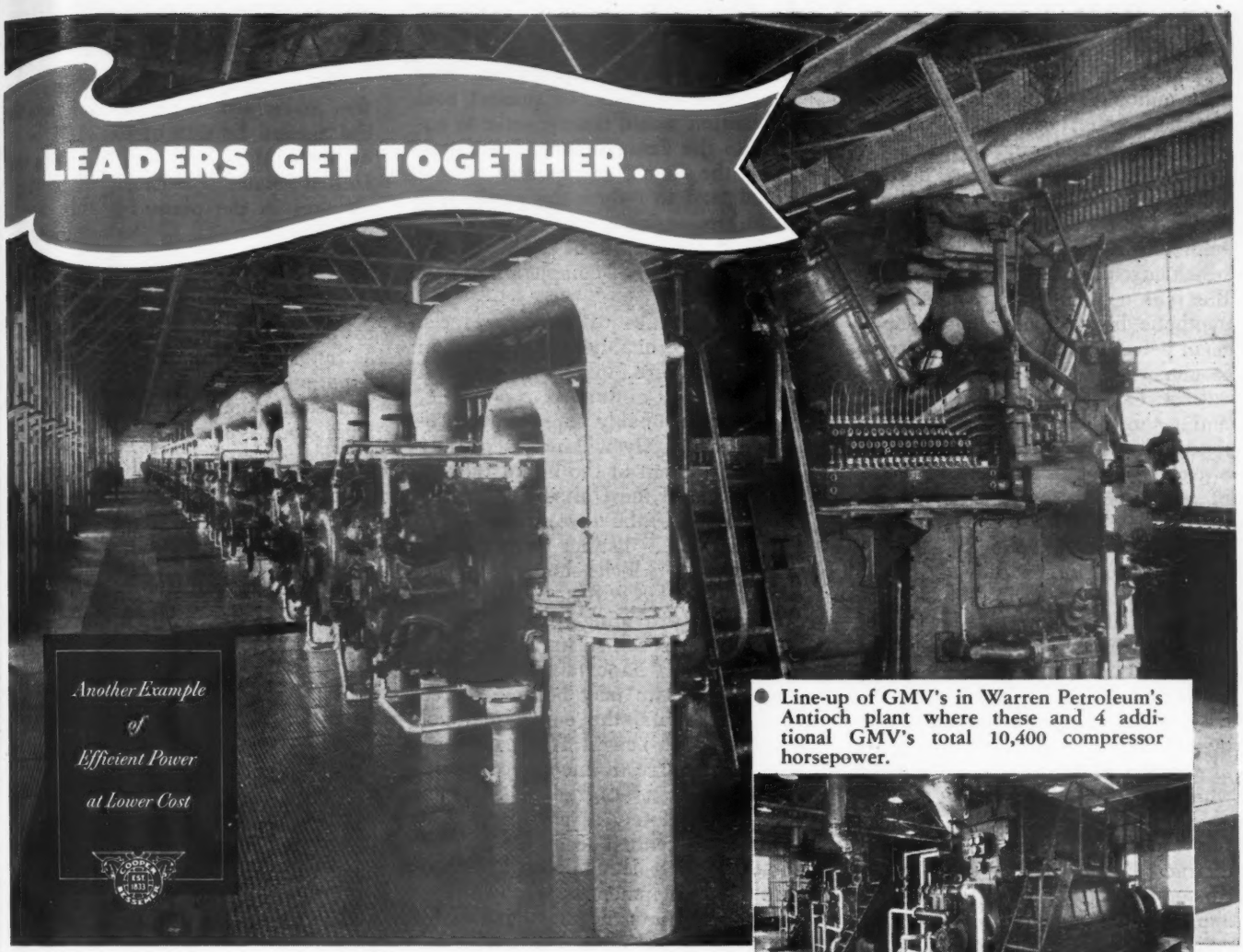
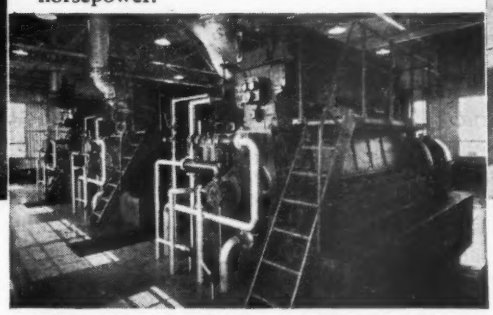
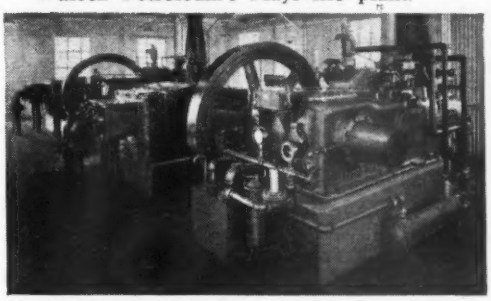


● Line-up of GMV's in Warren Petroleum's Antioch plant where these and 4 additional GMV's total 10,400 compressor horsepower.



● These three 505 hp Cooper-Bessemer JS-6 gas engines drive lean oil pumps in Warren Petroleum's Maysville plant.



● At Warren Petroleum's Holliday plant, Cooper-Bessemer 4 cylinder twin-line pumps, driven by Cooper-Bessemer 150 hp GAW gas engines, are in gasoline work, each handling up to 14,500 bbl of lean oil a day at 800 psi.

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from petroleum. They may be just as valuable as petroleum, but some products undoubtedly can be made from petroleum that cannot be obtained satisfactorily from supplemental sources. Likewise, certain products that can be obtained from oil shale and from synthetic liquid fuels obtained from gas or coal may not be obtained easily from petroleum. For this reason, it appears reasonable that synthetic liquid fuels should supplement petroleum for a number of years to come rather than strictly compete with it. From the military, economic, and technical viewpoint, it is fortunate that this is true, for it provides a greatly needed flexibility in the use of raw materials and in the products that can be obtained from the refining of the crude product.

In addition to generally recognized economic factors, which have been discussed herein in considerable detail, the utilization of natural gas for the production of liquid fuels has social and political implications, which may exert great influence on the future of the synthetic industry. The use of excess quantities of natural gas, for which no profitable market is available, in the production of synthetic fuels may be regarded as a measure of true conservation, even though the conversion process results in a loss of approximately one-half of the heating value of the gas. An entirely different attitude might develop if the future fuel supply of distant cities should be jeopardized by plans for the utilization of what may be a definitely limited gas reserve for the benefit of a synthetic industry. In many instances casinghead gas could probably contribute more to liquid fuel supplies if it should be returned to the oil-producing reservoir to improve recovery of crude oil than if used for any other purpose.

Possibilities for the exhaustion of coal reserves do not seem to be a matter of such public concern and do not receive the attention that is given to oil and gas even though some of the deposits possessing special qualities for the manufacture of good metallurgical coke in the Eastern States are reputed to be approaching exhaustion. Nevertheless, social and political aspects of the production of coal may be even more significant, on account of the sorry record of difficult labor relations and the unprogressive production technology which have characterized some of the operations of the coal industry for many years. Reduced coal production, resulting from strikes, has served to increase the demand for oil and gas for domestic use, for which purpose they encounter little difficulty in replacing the many inconveniences and deficiencies of antiquated or obsolete coal-consuming appliances. Any immediate diversion of present coal production would merely serve to aggravate the demand for oil and gas, and at the same time a scarcity of coal would tend to reduce the production of the steel industry and, in turn, thus diminish the amount of steel available for the drilling and completion of new oil wells.

The quantities of synthetic fuels, which will probably be available in the near future, unless the Federal Government undertakes a large, costly, and probably unprofitable program, very likely will represent only a small fraction of the liquid fuel requirements of the United States. The production of the these fuels, however, will be a distinct technological achievement, which should be welcomed both by government and industry in providing proof of the possibility of self-sufficiency of the nation in this important respect. As crude petroleum may become scarce in future years, the entire national economy will benefit if the change from one source to another of liquid fuel supply can be gradual, and can conform as closely as possible to the anticipated eventual decline in the production of petroleum.

If the development of the synthetic liquid fuel industry in the United States can be accomplished gradually, rather than precipitously, the possibility that plants will become obsolete before they are completed will be largely avoided. All new plants can then be built with the benefit of previous technological advances and discoveries, which might result in very large savings in development and operating expenses. The most important immediate requirement, particularly from the standpoint of national defense, appears to be that sufficient synthetic liquid fuel production should be developed to enable the perfection of pilot plant operations to commercial operations, and to provide experience in the operation of plants for technical personnel. With satisfactory techniques developed and operating skill acquired, a rapid expansion in the production of synthetic liquid fuels should be possible whenever a need for a supplemental supply develops. For this purpose, activity on the part of the Federal government in the preliminary exploration of methods and techniques should prove to be most helpful and should be welcomed. Thereafter, the development of synthetic fuel plants should conform to the needs for supplemental supplies of liquid fuels, and should be carried on by private industry without interference by the Federal government.

Acknowledgments

The material contained in this paper was assembled originally for use in the Second Edition of the API book on "Secondary Recovery of Oil in the United States." Because of certain changes in the plans for this book, only a minor part of the information so obtained could be used for the purpose originally intended. In consequence, the writer has had unusual sources of information available such as reports prepared by Armies of Occupation of Allied Military Governments, and the "Report on the Petroleum and Synthetic Oil Industry of Germany," prepared by the British Ministry of Fuel and Power. In addition, the writer had the active cooperation and received substantial aid from:

Dr. Harry H. Power, Chairman, Department of Petroleum Engineering, The University of Texas, and from R. A. Cattell, A. C. Fieldner, C. L. Moore, W. C. Schroeder, J. D. Doherty, A. J. Kraemer, and William H. Lyon, of the Bureau of Mines.

Many reports of the Bureau of Mines and papers prepared by members of the staff of the Bureau of Mines on shale oil and synthetic liquid fuels have been studied and reviewed. The statements and conclusions presented in this paper, however, are the writer's and do not represent in any way an official statement. Nevertheless, the writer does wish to express appreciation for the effort made by the Bureau of Mines to supply reliable information on the subject of this paper.

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* * *

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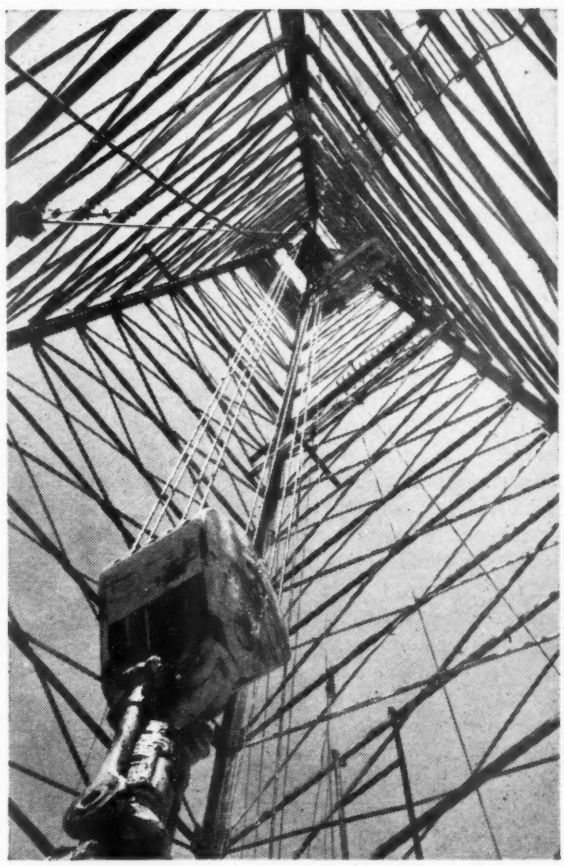

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PETROLEUM PROFILE

RALPH K. PAINE

RALPH K. PAINE, manager of Standard of Cal's pipe line department, is a native of Albany, New York, but at the age of four he was smitten with a severe case of wanderlust and migrated to California. Since that time he has become so thoroughly acclimated on the Pacific Coast that he no longer shows any evidence of an Atlantic origin. He does, however, offer proof of the fact that transportation engineers, like poets, are born, not made. At least it is certain that he gave unusually early indications of a bent for the juggling of dynes and poises. While attending the University of California, from which he graduated in 1922, he greatly improved the shining hour by spending his summer vacations on various engineering assignments, mostly concerned with pipe line station installations.

Immediately upon graduation he became a permanent employe of Standard of California, and in the intervening years has had a wide experience in the diverse phases of petroleum transportation. In the early days of his association with Standard he had a hand in the construction of two important oil arteries, designed and built to carry crude from the various fields in the San Joaquin Valley to the tanker loading plant at Estero Bay on the Pacific shore line. In 1929 he was transferred to Kettleman station as a engineer, at which time the Kettleman-Estero line was being constructed; and in 1935 he served as resident engineer when Shandon and Bitterwater stations were built on the Kern-Estero line.

During World War II, he was placed in charge of operations on the Stanpac 26-in. gas line, which was at the time being employed for the emergency transportation of crude oil, and was warmly commended for his capable handling of this assignment. After the war and before being elevated to his present post, Ralph Paine served as general superintendent of the southern district pipe line where he became acquainted with almost every known type of transportation operation—and operator.

Ralph is a tall, straight, young-looking chap with the weather beaten skin of an outdoors man, and a pleasant smile that he flashes easily and often. Like most oil men in high places his experience covers his field broadly and over a long time. He has worked in San Francisco, Coalinga, Kettleman Hills, Taft, and practically every field in the Los Angeles basin area, and there is little in the way of transportation engineering problems that he hasn't encountered and solved during the last 30 years.

By way of diversion he is addicted to occasional forays up into the High Sierras where he packs in to his favorite streams and tries to lure the astute denizens of the mountain rills into his creel with a cunning assortment of flies, moths, and such. Sometimes, for more violent exercise, he goes after the big ones in the salty waters of the California Gulf, and he can not only catch them, but having caught them can prepare them for the dining table expertly.

Indeed, we understand that he never misses an opportunity to play the role of fry cook and thus relieve Mrs. Paine of her kitchen ardors. We are not altogether sure that she appreciates this help, but nonetheless Ralph dusts off a bake board like one to the manner born, and can make as tasty a batch of cinnamon rolls as any journeyman fancy bread confectioner. He is distinctly proud, too, of the fact that another pipeliner, who shall be nameless, once sent one of his best recipes to a western magazine. The editor replied that the recipe would undoubtedly have been accepted for publication had it not been written in such forceful language. Altogether, Ralph Paine handles his considerable responsibilities with the ease that is indicative of competence, and he lives usefully, comfortably, and enjoyably.

Expanding Petroleum Frontiers

ALTHOUGH domestic petroleum production was curtailed appreciably during 1949, the search for new fields below 12,000 ft increased sharply with more than $100,000,000 being spent on the completion of 232 wells. This is more than twice the amount of money ($48,420,000) spent on the completion of 145 wells below 12,000 ft in 1948. The complete story of this record-breaking operation to expand our deep petroleum frontiers is contained in the article by Ernestine Adams, which begins on page B-7 of this issue of *The Petroleum Engineer*.

The former depth record of 17,823 ft was shattered again by Superior Oil Company in its Pacific Creek Unit No. 1 in Wyoming, which was drilled to 20,521 ft. The former producing-depth record of 14,505 ft held by Barnsdall in Los Angeles County, California, was lost to Standard of California, which completed its Mushrush No. 5 well in the Wasco field of Kern County, California, for good production of high gravity oil from 15,440 to 15,530 ft.

Although deep wells are very expensive, costing about $432,000 on the average during 1949, they are apparently located very carefully, for 124 of the 232 deep tests were completed as producers of petroleum. Of the 152 wildcats or semi-wildcats included in the 232 deep tests, 64 were completed successfully as producers. Of the 70 field wells drilled, 60 were completed successfully; and 10 of the 232 deep tests were either shut in or working over at plugged-back depths.

Thirty-two new fields and 32 new sands or extensions were discovered as a result of deep tests drilled in 1949. Seven of the new fields were below 12,000 ft; 23 new fields were between 8000 and 12,000 ft; and 2 of the new fields were discovered at plugged-back depths of less than 7000 ft. Of the 32 new sands and extensions, 14 were below 12,000 ft, and 18 were at plugged-back depths above 12,000 ft.

As a whole, the deep drilling in 1949 was very successful from an economic standpoint. One field alone, the Pegasus field of Midland and Upton Counties, Texas, has proved reserves now of more than 100,000,000 bbl. Several other important deep fields are being developed, and hundreds of new deep fields remain to be discovered by the operators who are able and willing to continue the search for deeper petroleum reservoirs. The pioneer spirit of the domestic operators will continue to expand our petroleum frontiers.

K Marshall Fagin

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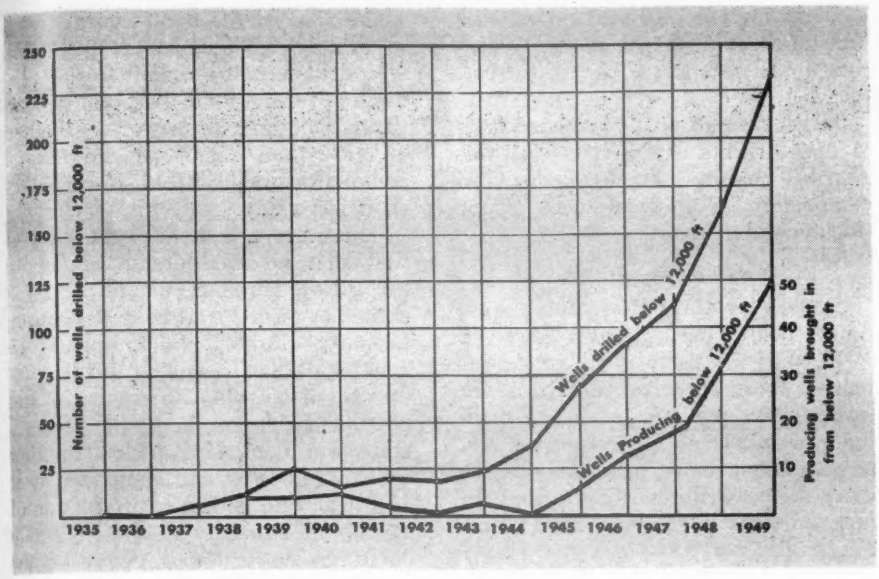

Total deep wells drilled and new wells producing from 12,000 ft or below show sharp upturn in last five years.

Deep Drilling Last Year Cost $100,000,000

Exploratory Wells Below 12,000 Ft Are Twice as Successful as the Average in Finding Production

ERNESTINE ADAMS*

THE U. S. oil industry laid a hundred million dollars on the line in 1949 to explore and develop structures below 12,000 ft in depth. A total of 232 deep wells were completed during the year for this amount.

The sharp increase in deep drilling and deep producers is seen at once in the curve above.

The biggest news of the year in deep drilling was the fact that two important records were set. Superior Oil Company Pacific Creek Unit No. 1 drilled below 20,000 ft to make a first in oil history and Standard Oil Company of California for the first time *found oil below 15,000 ft.*

The 20,521 ft† depth of the Pacific Creek well in Wyoming was the second time in 1949 that Superior broke its own record of 17,823 ft (Weller test in Oklahoma). The Oklahoma well, drilled in 1947, remained the record depth well in 1948. Then Superior drilled the Limoneira well in Ventura County, California, to 18,734 ft in March, 1949 for a new depth record. It is still the only well below 18,000 ft except the Pacific Creek test.

Standard of California Mushrush No. 5 extended the producing depth more than 1000 ft. Last year Barnsdall's RSF 66-9 in Los Angeles County, California, was the deepest producer, with the production sand reaching 14,505 ft. The only other time such a large footage was added to the production depth record was in 1938 when Continental brought in the famous KCL A-2 with production as deep as 13,180 ft, a record that was held for five years.

The Mushrush well was a deep test (TD 15,866 ft) in the Wasco field, Kern County, California, and discovered good production of oil of high gravity at 15,440-530 ft.

Besides the Mushrush No. 5 deep pool discovery, *63 other wells* out of the 232 wells drilled found production. Of the total 32 were new fields and 32 were extensions and/or new sands. Twenty new pools were found below 12,000 ft; 7 of which were new fields and the others new sands or extensions to present fields.

Of the total wells drilled below 12,000 ft 162 were wildcats or semi-wildcats and 70 were development wells. Ten of the field wells were dry and 88 of the wildcats were dry. Nine wells, which were deep tests, were plugged back to production in shallow fields.

Table 1. Deep wells for 1949.

	Dry	Producers	Total
Wildcats or semi-wildcats	88	64	152
Field wells†	10	60	70
Shut in, working over, etc.	10		10
Total	108	124	232

†This includes deep tests that are completed in upper zone field.

New fields and extensions are divided by depth as follows:

Table 2. Discoveries by deep wells.

Below:	New fields	New sands & extensions
3,000 ft	1	
4,000 ft		1
5,000 ft	1	
7,000 ft		1
8,000 ft	5	4
9,000 ft	5	2
10,000 ft	7	4
11,000 ft	6	6
12,000 ft	4	9
13,000 ft	3	3
14,000 ft		1
15,000 ft		1
Total	32	32

On the whole this looks like a very good record for the year. No matter how you compare the deep exploratory wells to those of all depths, the percentage of productive wells is more than twice as high for deep wells as for wells drilled to all depths. This is as it should be because a deep well is exploring various strata at different depths in one operation whereas a shallow wildcat or outpost well explores a wider area but fewer strata.

Increased Costs

Vertical exploration is invariably more expensive than area exploration. The $100,000,000 figure is made up of actual figures supplied by the operators, and this is only for wells

*Managing Editor.
†Oil wells mentioned can be found in Table 3, listed according to total depth.

EXCLUSIVE

drilled in the U. S. It does not include, for instance, the Burmah Oil Company well in Pakistan that cost more than £2,000,000 to complete nor the French well, down to 13,870 ft after drilling since July 13, 1946 and not completed. Two deep Canadian wells, both drilled by Canadian Gulf Oil Company, and the German well near Hanover, drilled by Shell and Standard of New Jersey, are also excluded from cost estimates.

Deep drilling costs in 1949 averaged about $432,014 a well, the highest average cost on record since the first well was drilled below 12,000 ft in 1935*.

This high cost is due in some measure to the 11 deep wells in the Gulf of Mexico, which averaged $872,820 for each well. It is reasonable to estimate that much of this extremely high expense can be charged to the experience of learning open water drilling methods and will not be recurring.

Another reason for the increased cost is more intangible but nevertheless real. Paradoxically, it is the result of learning more about how to drill deep. In earlier deep drilling attempts the hole was often junked and abandoned above the 12,000-ft mark if tools were lost, pressures dangerously high, or circulation lost in loose formations when the hole got deep.

Circulation is hard to maintain at these depths but now a well is seldom abandoned. One operator spent nearly $300,000 for drilling mud for one well because of circulation problems. Many operators pointed out that high costs were due to the use of huge quantities of mud because of shale and lost circulation. It might cost less to give up the test but it would not prove oil and gas reserves. Incidentally, the well that required almost $300,000 worth of mud did find a new field.

The reservoir pressure estimated at above 12,600 psi did not prevent Tide Water Associated Oil Company from bringing in a new field from 12,985-13,007 ft at Manila Village, Jefferson Parish, Louisiana. It wasn't long ago that the equipment couldn't have stood that pressure, regardless of the skill of the drilling crew. Rowan Drilling Company eased the Tide Water well in with little trouble, using heavy mud, small choke, and 15,000-psi christmas tree.

When the deepest oil well in the world, Superior's Pacific Creek Unit No. 1, had a fishing job at 16,880 ft, operations did not cease. It took 36 hr with modern fishing tools to release the tools but it was accomplished and the drilling went on to the destined depth.

*See *"Production Depth Record Shattered,"* by Ernestine Adams, *The Petroleum Engineer*, February, 1949.

Diamond bits and extra hard rock bits eat through deep hard formations that would once have defeated the project.

The higher costs for experimenting in deep drilling in the open Gulf this year will pay off in coming years when exploration and development of the tidelands increases.

New Deep Fields

Some very impressive fields were found below the 12,000-ft mark in 1949. It is too early to judge the extent of these subterranean fields but several have inaugurated heavy drilling programs and their reserves can be estimated more accurately when more of this drilling is completed. In fact, 45 wells had been drilled below 12,000 ft at the end of 1949 but had not been completed by January 1, 1950.

ACKNOWLEDGMENT

Deep-drilling operators have generously supplied valuable data on deep wells in this sixth annual survey of drilling below 12,000 ft. We fully appreciate the amount of effort required to give us this fine cooperation.

Because of the great expense involved in this type of drilling, information that helps to plan and execute such a project is worth study. Eight per cent of all drilling costs are expended for wells below 12,000 ft. We hope that the data published here and in a coming article will help guide further deep operations.

Three of the seven new fields, all promising Ellenburger pools, are in Texas. Shell Oil completed its No. 1 W. L. Hawkins, Gaines County, early in the year with a prolific initial production of 844 bbl 40.8 gravity oil. (TD 12,306 ft).

Magnolia Oil Company brought in the bonanza Pegasus (doubtless another name for the Flying Red Horse) field in March. An Upton County Ellenburger discovery the No. 1-A TXL produced initially 1167 bbl of 52.3 gravity oil. It was drilled to 13,295 ft and plugged back to 12,825 ft. There is extensive drilling in the area now.

Also in March The Texas Company brought in the Warfield field, Andrews County, with its Clarence Scharbouse et al No. 1. An initial production of 44 bbl 46.9 gravity oil and 30,200,000 cu ft gas a day came from 13,049 ft. (TD 13,374 ft).

In Louisiana two deep fields were found, both unusual. One was the high pressure reservoir that required expert handling — Tide Water No. 1 State Lease No. 1299, the discovery well at Manila Village, Jefferson Parish. The drill went to 13,050 ft and production was found just above that depth. The high pressure is estimated at more than 12,600 psi, and initial production was 179 bbl and 934,000 cu ft gas a day.

The other new field is the kind of find that oil men dream about. In the spring Humble Oil and Refining drilled to 14,650 ft at Lake Raccourci, Lafourche Parish, and completed the well at 10,000 ft with an initial production of 163 bbl 57.5 gravity oil and 880,000 cu ft gas in April. Immediately the company drilled another well to 14,045 ft and completed it at 12,146 ft with an initial production of 120 bbl 56.2 gravity oil and 5,559,000 cu ft gas. A third well, begun on the same day and drilled to 14,923 ft was completed at 14,470 ft with an initial production of 179 bbl 48.4 gravity oil and 4,123,000 cu ft gas. Thus Lake Raccourci field begins with three producing levels.

In Oklahoma Gulf Oil Corporation completed the No. 1 Mainka for a good producer for a long period (it was spudded in December, 1947) but the effort paid off. Situated in Grady County, the well went to 14,013 ft and is producing from 12,900-13,567 ft in the First and Second Bromide Sands, Tulip Creek, and McLish Sand. Initial production was 1068 bbl 46.5 gravity oil and 1,815,000 cu ft gas.

A new deep field in New Mexico was brought in by Amerada Petroleum Company. Its No. 1 Hamilton discovered the Knowles field at 12,518-600 ft in Lea County. Initial production was 935 bbl 46.9 gravity oil and 169,000 cu ft gas. This is the second deep field for New Mexico, both of which appear to have excellent prospects. The Crossroads field, found last year, is developing satisfactorily.

New deep pools in old fields increased by six the number of producing sands below 12,000 ft. In California the Standard of California Mushrush No. 5 brought in the world's deepest production with a substantial initial run of 352 bbl 40.4 gravity oil 1218 cu ft gas.

Western Natural Gas Company No. 9 St. Charles Ranch, Aransas County, Texas, is shut in after discovering several new sands.

Tide Water found a new sand at 12,300 ft in the Venice field, Plaquemines Parish, Louisiana. The No. 45 Buras Levee District drilled to 12,352 TD in 60 days. The Miocene B-45 sand at 12,300 ft produced 374 bbl 37.9 gravity oil and 538,500 cu ft gas a day on the initial test.

Section 28 in St. Martin Parish got

(Text Continued on Page B-38)

TABLE 3. DESCRIPTION OF WELLS DRILLED TO 12,000 FT OR BELOW IN 1949.

TD,ft PB,ft	Complt'd Spudded	Company and name of well	Drilled by	Field,County State	Casing and cementing schedule	Init.prod., grav.,choke	Wellhead pressures*	Remarks
12,000	8-16-48 2-6-48	Magnolia 1 Britt-Chitwood	Vierson & Cochran	Chitwood Grady,Okla	13 3/8"@721'; 9 5/8"@5130'; 7"@11,229'	350 B 44.5° 9/64"	ST 3500 GOR 2330	FW. DT 192. 72 perf @ 11,710-24', Boat-wright sd. 5 cores. 1 DS.
12,000	12-6-48 3-24-48	Magnolia 2 A.V.Spiers	Decon Drlg	Chitwood Grady,Okla	20"@69'; 13 3/8"@877'; 9 5/8"@5282'; 7"@ 11,119'	250 Mcf	SC 900 ST 900	FW. DT 233. Prod 11,420-46',Spiers sd.
12,000	12-22-49 9-2-49	Magnolia 1-A Denison,La Canal Unit	Co.rig	Iowa Calcasieu, La	20"@210'; 13 3/8"@1719'; 9 5/8"@9594'; 7"@ 10,566'	231 B 46.6° 2977 Mcf 10/64"	C 7770 SC 7950 GOR 38,690	FW. DT 111. Prod 1750', 15th sand. DS 10,475-90'.
12,000	1-26-49 7-23-48	Rumble F-1 K.R.West Laureles	Co.rig 19	W.Laureles Kleberg,Tex	5 1/2" 11,983' N-80, 23 & 20# 600 sx Trin. Inf.	D&A		WC. DT 115. 114 perf @ 11,234-53'. 71 WL, 56 SW cores. 3 DS.
12,000	1-17-49 6-26-48	Gulf 1 Olive Boling	Loffland Bros	S.Lake Charles, Calcasieu, La	20" 48# 250 sx; 13 3/8" 61# & 54.50# 1000 sx; 9 5/8" 40# & 47# 1000 sx; 7" liner 26# 1000 sx	23 B 53° 845 Mcf 1/8"	T 3100 ST 3500 GOR 36,800	WC. DT 166. 36 perf @ 10,008-14'. 84 cores. Natural mud; lime-starch. New field. IR 3985 psi, T 203F, D -9990'. Bits, rock 63, drag 15.
12,000	7-10-49 1-25-49	Gulf 1 Pellerin, et al	Co.rig 43	Sec 28, St Martin, La	16" 73.81' 38.50# spiral 237 sx; 10 3/4" 2518.77' 40.50# SS 1000 sx; 5 1/2" 11,013' 17&20# J-55 & N-80 500 sx	179 B 35.8° 1010 Mcf 5/32"	T 3000 GOR 5810	FW. DT 146. 32 perf @ 10,950-58', Frio, 40' thick. Salt dome. 127 cores. IR 4533 psi, T 232F, D -10,937'. Bits, rock 57, drag 21. Natural mud; oil emulsion; and lime-starch-emulsion mud.
12,001	1-11-49 8-10-48	Sun 2 Niblett Farms	Falcon	Jefferson Davis,La	20" 79' 48# S-Y; 13 3/8" 1909' 61&54.5# J-55; 9 5/8" 9797' 43.5# & 40# S-Y; 7" 11,250' 23&26# S-Y.	D&A		WC. DT 186. Deepest form. Frio.
12,001	12-31-48 7-23-48	Gulf 1 Hy Melancon	Co.rig 43	St Martin, La	16" 75' 30 1/2 & 38.50# spiral 250 sx; 10 3/4" 2489' 40 1/2# SS J-55 100 sx; 5 1/2" 11,691' 15 1/2, 17 & 20# J-55 & N-80 SS 750 sx	307 B 31.9° 230 Mcf 5/32"	T 1300 GOR 748	FW. DT 134. 48 perf @ 10,672-80', Frio, 40' thick. Salt dome. 137 cores. IR 4927 psi, T 208F, D -10,665. Bits, rock 66, drag 17. Natural mud.
12,002 10,805	10-17-49 7-11-49	Stanolind 1 Gauthier Unit	Co.rig	Sec. 28 St Martin, La	10 3/4"@2521' 946 sx; 7"@11,030' 750 sx; 5 1/2" 10,896-11,601'	32.4 B 1600 Mcf	GOR 50,500	FW. DT 82. 36 perf @ 10,799-805', Frio. Salt dome. Mud, Bentonite & phos.
12,005	8-27-49 3-27-49	Humble 1 G.King Ranch	Allen & Morris	E.Laureles Kleberg,Tex	7" 9013' 29&23# N-80 & J-55 525 sx Uniflo.	35,000 Mcf	T 2522 GOR 125,000	WC. DT 55. 32 perf @ 6497-505', Frio. 234 WL, 34 SW cores. 21 DS. Bits, rock 93, drag 10.
12,010	5-6-49 10-9-48	Am.Republics 1 Pipkin	Co.rig	Jefferson, Tex	16"@120' 38# 125 sx; 10 3/4"@3462' 40 1/2# 1800 sx Uniflo; 7" 8R thread. Rge 2 & 3 - N-80; 2426' 29# btm; 1011' 26# middle; 7025' 23# top, set 10,476' 500 sx Lone Star	D&A		WC. DT 210. Salt dome. Bits, rock 29, drag 50. Red lime starch mud.
12,012	8-9-49 5-22-49	Western Gulf 23-1	Loffland Bros	Paloma, Kern,Calif	7" 26,29,32# Seamless LT&C N-80	240 B 35° 163 cu ft. 12/64"	Pkr T 525 psi Pkr ST 1080 psi GOR 680	FW. DT 79. 2" SL, 200W, 12R, 6" @ 11,375-12,009', Stevens, 600' thick. Anti-cline. 22 cores. IR 3185 psi, T 254F, D 10,600, PR 3100 psi. Water base mud to top of sd, oil base from top of sd to TD.
12,012	2-9-49	H.L.Hunt, et al Sam F.Wilson		S.F.Austin #3 Survey Galveston, Tex		3/8"		WC. Deepest form. Shale. Shut-in. Gas well, non-commercial.
12,014	9-9-49 3-12-49	Gulf 19 Lafourche Levee	Co.rig 2	L.Hermitage Plaquemines La	20" 104' 48# spiral 200 sx; 13 3/8" 2545' 54.50 & 61# SS 1000 sx; 9 5/8" 9187' 40 & 47# SS 800 sx; 7" 10,130' 26# SS 140 sx; 5" 11,994' 18# SS	D&A		FW. DT 95 days. Bits, rock 28, drag 10. Natural mud; saturated salt water.
12,016	6-23-49 4-13-49	Humble 1 La Citrus Lands	Murray	Poverty Pt. Plaquemines La	9 5/8" 9013' 43.5# N-80 500 sx	Dry		WC. DT 64. Deepest form, Miocene. 46 SW cores. Rock bits 21, drag 5. Red lime starch mud.
12,020	11-1-48 4-26-48	Western Nat. Gas 9 St Charles Ranch	Longhorn Drlg	St Charles, Aransas,Tex	20"@120' 48# 300 sx; 13 3/8"@2471' 54.40 & 60# 2200 sx; 9 5/8"@8010' 40, 43.5 & 47# 1500 sx; 7"@11,067' 29&32# 1250 sx; 5" liner @ 11,867' 18# 115 sx.	Gas and Condensate		WC. DT 142. Discovered several new sands. Faulted structure. Shut in. Lime Impernex.
12,020 8,712	8-30-49 2-28-49	Magnolia 21 E.P.Cowden "B"	Co.rig	Dollarhide, Tex	13 3/8"@320'; 9 5/8"@3030'; 7"@8720'	112 B 39.9° 3/8"	GOR 346	FW. DT 147. 184 perf @ 8424-70', Silurian.
12,033	12-24-49	Union-Calif. 6-C, La.Furs	Hillburn	Fresh Water Bayou, Vermilion, La	16"@159' 150 sx; 10 3/4"@2739' 40.5# J-55 1500 sx	Abandoned		WC. DT 48 days. 37 bits. Phosphate mud system.
12,037		Shell B-5 Smith-State		Weeks Is. Iberia,La				FW. Temporarily abandoned.
12,056	4-13-49 11-29-48	The Tex.Co. 1 Wm.M.Rice Inst	Grey-Wolfe	Waller, Tex.		40 B cond. 51° 4000 Mcf 12/64"	GOR 100,000	WC. 48 perf @ 10,290-304', Wilcox, 30' thick. Monocline. Shut in.
12,065 9,530	9-12-49 1-12-49	Stanolind 1 Leonard Oil	Gardner	Lea,N.Mex	13 3/8"@522'; 9 5/8"@3726' 1200 sx; 7"@ 9410' 200 sx	24 B 38°		WC. DT 200. Ellenburger, deepest. Devo-nian, prod. Rock bits 236. Bentonite and phos.
12,067	7-22-49 9-7-48	Magnolia 1 Eugene Is. St.Lse 686 Blk 110	Co.rig	Eugene Is. Iberia,La	30"@150'; 20"@495'; 13 3/8"@2485'; 9 5/8" @7995'; 7"@10,974'	Gas 53.6°	GOR 163,900	WC. DT 302. Prod depth 9920-72'. Deepest formation, possible salt.
12,074	1-31-49 4-12-48	Humble 1 J.C.Mitchell	McQueen & Clevenger	Mitchell Block Terrell,Tex	7 5/8" 10,289' 33.7# N-80 29.7# J-55 29.7# N-80 1890 sx	Dry		WC. DT 273. 9 perf jobs-982 holes @ 7720-8850', Pennsylvanian, deepest. Bits, rock 212.
12,080	11-5-49 7-5-49	Samedan 1 E.A.Andrews	Noble Drlg	Robertson Gaines,Tex	13 3/8"@306' 61# J-55; 9 5/8"@6482' 40# N-80; 7"@8245' 26# N-80; 3999' of 29# 7". 372 jt.	Dev. 254 B Ellen.262 B 39°	Flowing: 550 Dev. 50 Ellen. Shut-in 600 Dev. 100 Ellen.	WC. DT 124. Prod, 10,056-70' & 11,900-60'. Devonian-Ellenburger discovery. 75' thick. Anticline. 56 perf @ 9956-70', 240 perf @ 11,900-60'. Rock bits 155. Dual completion.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

TABLE 3.—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949.

TD, ft PB, ft	Complt'd Spudded	Company and name of well	Drilled by	Field, County State	Casing and cementing schedule	Init. prod., grav., choke	Wellhead pressures*	Remarks
12,084	1-24-49 9-18-48	Sun 33 Dibert-Stark-Brown	Co. rig	Chacahoula Lafourche, La	16"@84' 38.5# Naylor; 10 3/4"@1933' 40.5# J-55; 7"@10,394' 23# S-95-E N-80	Gas		Pool WC. DT 152. 100 perf @ 8856-81', Miocene, 50' thick. Flank salt dome structure. Shut-in.
12,091	6-14-49 4-2-49	Humble 27 Cockrell-Moran	Rowan Drlg.	L. Washington Plaquemines La	5 1/2" 12,053' 20&17# N-80 200 sx Uniflo	Dry		WC. DT 52. Deepest form., salt. Rock bits 15.
12,092	6-20-49 12-27-48	Humble 2 W.L.Moody 17 H.R.Wallis	Texas State Drlg	S. Mayes Chambers, Tex	7" 12,074' 26# J-55&N-80 200 sx	40 Mcf 48.0°	T 4400 GOR 6350	FW. DT 133. 60 perf @ 12,020-50', Frio. Bits, rock 53, drag 33.
12,094	1-8-50 8-2-49	Tidewater, et al 1 J.P.Hystel	Rowan Drlg	Corrigan, Terry, Tex	13 3/8" 296' 36.0# slip joint/300 sx; 9 5/8" 5893' 40.0# J-55 S-R/3000 sx; 5 1/2" 11,715' 17.8# N-80 S-R/1250 sx.	1121 B 35.1° 20 Mcf 3/4"	Pkr 75# GOR 18.1	WC. DT 145. 268 perf @ 11,475-542', Fusselman lime, 67' thick. 6 cores. 15 DS. IR 4938 psi, T 142 F, D -8334' (11,500'). Rock bits 187.
12,120	8-9-49 6-18-48	Union-Cal. 1 C.C.Krumbhaar	Loffland Bros	Houma Terrebonne, La	20" cond.drive pipe; 10 3/4"@2448' 40.5# J-55 1350 sx; 7"@12,055' 26,29&32# N-80 700 sx	Shut-in 1/4"	Flowing: Pkr 4550 Shut-in Pkr 4800	Semi-WC. DT 40. 42 perf @ 11,815-29', Dupont Sd, 105' thick. Deep seated dome structure. Mud phosphate. Awaiting production facilities. Bits 30.
12,127 9,685	6-21-49 10-9-48	Magnolia 1 Cox Federal	Gardner Bros	Crossroads Lea, N.Mex	13 3/8" 353' 32.4#; 9 5/8" 6189' 40#; 7" 9760' 26#	Dry		WC. DT 200. 24 perf @ 9676-82', Devonian. 2 cores. DS 9646-9760.
12,133	10-3-48 4-12-48	Republic Nat. Gas A-1 Rose H.Barnett	Trinity Drlg Co.	Benedum Upton, Tex	13 3/8" 342' 54.5# J-55; 9 5/8" 3830' 40# N-80; 7" 11,594' 26&29# N-80	32 B 5 hr 15/32"	Pkr T 850	Semi-WC. DT 152. 272 perf @ 11,242-11,310' Found new prod. sand, Fusselman, 75' thick. Anticline structure. 9 DS. IR 5011 psi, T 194 F, D -8400, PR 4022 psi. Rock bits 125.
12,135	11-28-49 9-23-49	The Tex.Co. 2 State Is.1248 Lake Pelto	Co. Drlg Bge.	L.Pelto Terrebonne, La	10 3/4"@3634' 500 sx; 7"@10,652' 382 sx.	341 B 33.9° corr.	T 4000 GOR 1029	WC. DT 60.
12,143 11,530	9-25-49 6-24-49	Stanolind 2 P.H.Maraist	Co.rig	Sec. 28 St Martin, La	18"@125' 200 sx; 10 3/4"@2510' 950 sx; 7"@ 11,591' 950 sx.	120 B 86 Mcf 6/64"	T 1550 GOR 7800	FW. DT 95. 30 perf @ 11,470', Frio sd. Salt dome. 52 bits. Mud, Bentonite and phos.
12,150	8-21-49 2-25-49	Mid-Continent 1 U.D.Sawyer	Zephyr Corp	Crossroads Lea, N.Mex.	13 3/8"@258' 300 sx; 9 5/8"@4651' 36# 2125 sx; 5 1/2"@4190' 20# 7956' 17# 1090 sx	625 B 42.6°	C 300 T 200 GOR 35	Well extended field. Form, 11,950-12,150', 200 perf @ 12,000-12,050. 4 DS.
12,166	8-15-49 6-10-49	Union Sulphur 1 Kahn Brousard	Co.rig 3	Acadia, La	45 jt. 10 3/4"@1825' 40.5# S-40 400 sx; 241 jt. 7"@11,049' 26# S-95 750 sx; 40 jt. 5"@ 12,166' 10# liner 350 sx	34 B 44.5° 1904 Mcf 6/64"	C 500 T 5500 GOR 56,000	Well extended field. DT 51. 16 - 1/2" perf. @12,070-4', Chickasawhay, 82' thick. Faulted structure. 60 cores. IR 8380 psi, T 208 F, D 12,000'. Rock bits 51.
12,181	8-15-49 3-14-49	Plymouth 1 B. Taylor & Sadler	Noble Drlg Co.	Benedum Upton, Tex	13 3/8"@310' 300 sx; 9 5/8"@3687' 2600 sx; 7"@9956' 750 sx.	Working over		FW. DT 155. Deepest formation, Ellenburger.
12,200	8-7-49 4-3-49	McCarthy Oil & Gas 1 R.F.Wiley		Collins L. Brazoria, Tex.		20.9 B 65.° 4908 Mcf	C 2045	
12,200	6-20-49 3-9-49	The Tex. Co. 1 Rojas-Adam	Co.Drlg Bge.	Lafitte Jefferson, La	13 3/8"@2007' 500 sx; 8 5/8"@11,900' 1000 sx	6 B 18 corr.	GOR 98,000	WC. DT 84. Prod, 4331-44'.
12,203	2-13-49 12-22-48	The Tex. Co. 8 St.Lse 329, St. Mary Ph. Land Unit 1	Co.Drlg. Bge.	Horseshoe Bayou St Mary, La	10 3/4"@1825' 500 sx; 7"@12,203' 750 sx.			FW. DT 50. Temporarily abandoned.
12,210	7-28-49 4-10-49	Humble E-1 Gulf Coast Realties	Loffland Bros	SW Lake Trafford Collier, Fla	9 5/8" 4226' 40# N-80 400 sx Portland	Dry		WC. DT 107. Deepest form, Cretaceous. 40 WL cores. Bits, rock 37.
12,213	12-19-48 7-26-48	Gravis & Mitchell 1 Opdenweyer Alcus		St Gabriel Iberville, La		475 B 40° 9/64"	T 5025 GOR 1922	FW. Deepest form, shale. Perf, 11,440-455 w/60, 2" @ 11,257' on pkr.
12,215	6-28-49 9-5-48	Shell Clear Creek	Kerr-McGee	Clear Creek Sheridan, Wyo.	13 3/8"@534' 48# J&L Seamless 400 sx; 7"@ 10,335' 300 sx.	D&A		WC. DT 282. Deepest form, Cambrian. 62 cores. 5 DS. Bits, rock 112. Mud, clay base.
12,231	1-21-49 6-22-48	Mid-Continent 1 Dessie Sawyer	Zephyr Corp	Crossroads Lea, N.Mex.	13 3/8"@240' 300 sx; 9 5/8"@4604' 36# 4850 sx; 5 1/2"@12,208' 20&17# 2000 sx.	355 B 44.6°	C 340 T 400 GOR 80	FW. DT 218. 380 perf @ 11,740-840', Devonian. 4 cores. 10 DS.
12,239	6-23-49 4-25-49	Tidewater D-5 Manhattan Land & Fruit Co.	Rowan Drlg	Venice Plaquemines La	20" 200' 66.2# slip jt 300 sx; 13 3/8" 2507' 54.5# J-55 750 sx; 9 5/8" 6111' 43.5# N-80; 9 5/8" 3470' 40.0# J-55 1000 sx; 5 1/2" 6718' 17.0# N-80; 5 1/2" -5536' 17.0# J-55 1000 sx. (All S-R)	300 B 34.5° 306 Mcf 9/64"	Pkr ST 2125 GOR 1020	Extended field. DT 47. Prod, 11,650', in Miocene B-30 sd, 100' thick. Salt dome. 48 perf @ 11,657-665. 144 SW cores, 9754-12,164'. Bits, rock 50.
12,245	8-1-49 5-17-49	Hunt 1 Fernand Bordelon		Markesville Avayelles, La		D&A		103 4" perf @ 1260', Shale Tuscaloosa.
12,247	8-21-49 4-3-49	Shell 1 Hutley Unit	Helmerich & Payne	Washita, Okla	16" 130' 55# EW 150 sx; 10 3/4" 2731' 51# SS 1800 sx.	D&A		WC. DT 140, (rig time). 6 cores. 8 DS.
12,250	10-27-49 9-3-49	The Tex. Co.10 St.Lse 329 St Mary Ph. Ld Unit 1-10	Co.Drlg. Bge.	Horseshoe Bayou St Mary, La	10 3/4"@1835' 500 sx; 7"@11,946' 850 sx	244 B est 33.7 corr 10/64"	T 1325 GOR 704	FW. DT 44. Prod, 11,818-28', Shale and lime.
12,255 10,410	9-12-49 2-9-49	Magnolia 1 Flanagan Est.	W.H.Black Drlg Co.	Gaines, Tex	13 3/8"@333'; 9 5/8"@4420'; 7"@12,240'	182 B/14 hr 38.2° 1/4"	GOR 743	WC. DT 162. Prod, 10,345'. Deepest & prod formation, Clearfork Devonian. 88 perf @ 7228-50' & 10,345-82'.
12,260	3-4-49	Tidewater 61 L&W		Ventura, Ventura, Cal.		604 B 34.3° 876 Mcf 20/64"	T 500	

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

TABLE 3—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949*

TD,ft PB,ft	Complt'd Spudded	Company and name of well	Drilled by	Field,County State	Casing and cementing schedule	Init. prod., grav.,choke	Wellhead pressures*	Remarks
12,262	12-20-49 12,262	Gravis & Mitchell 2 Alcus Cypress		Iberville, La		165 B 54 3000 Mcf 13/64"	T 3050	FW. Perf. 60/88 @ 10,976-11,038'.
12,263 12,257	1-25-49	Magnolia 1-C Santa Fe-Pacific	Black Drlg Co.	Crossroads Lea,N.Mex	13 3/8"@320' 48#; 9 5/8"@6198' 40#; 7"@ 12,240' 32#	350 B 42 10/64"	C 650 T 300	FW. DT 199. Prod 12,240-63', Devonian, 23' thick. 9 cores. DS 12,191-44'.
12,279	6-15-49 11-13-48	Sun-Sohio 1 Am.Ld.Co.	Weans	Estherwood Area Acadia,La	20"@80' 48# Naylor; 13 3/8"@2745' 54.5 & 61# J-55; 9 5/8"@9903' 43.5 & 47# A.O.Smith S-Y N-80; 7"@11,800' 23&26# S-Y N-80	D&A		WC. DT 185 days. Deepest formation, Frio.
12,292	6-30-49 12-8-48	Cotton Valley Oper Comm. 1 Pardee Unit	Woolf & Magee	Cotton Valley Webster, La	5" 8950' 15# XL J-55 100 sx	105 B 63.6 1665 Mcf 1/4"	C 1125 T 2750 GOR 15,850	FW. DT 145 days (deepened). Prod 8427'. Bodcaw sd, 35' thick. Anticline structure. 150 perf @ 8427-55'. 15 cores. IR 3300 psi, T 240F, D -8430', PR 3250 psi.
12,297	10-12-49 8-3-49	Union Sulphur 6,Mayo Reeves	Co.rig 6	Gillis Calcasieu, La	9 5/8"@6851' 36# 400 sx; 7 5/8"@9051' 29.7# Hydrill F.J., top @6487' 425 sx	62 B 35.7 70 Mcf 1/4"	T 800 GOR 1130	WC. Deep test. DT 70. Prod 8932-42', Hackberry, 14' thick. 11,440' top of Jackson, 12,297' Cockfield (?). Faulted structure. 40 perf @ 8932-42'. 60 cores. Bits, 58 rock.
12,306	1-20-48 6-14-48	Shell 1 W.L.Hawkins	Co.tools	Flanagan Gaines,Tex	13 3/8"@264' 54# SS H-40 225 sx; 10 3/4" 45.5# SS H-40; 8 5/8"@4286' 32# SS J-55 & H-40 4000 sx; 5 1/2"@12,174' 17&20# SS J-55 & N-80 600 sx; 2"@12,251' 6.7# EVE N-80.	844 B 40.8 1"	C 265 T 190 SC 1045 ST 995 GOR 225	WC. DT 209. Disc. new field @ 12,220', Ellenburger, 93' thick. Seismic selection. IR 5043 psi, T 154F, D -8904', PR 4617 psi. Bits, 191 rock. Mud, Agma Gel & water.
12,318	8-19-49 5-5-49	Superior 1 LL&E State Unit 18	Co.rig	Four Isle Terrebonne, La	18" conductor pipe@128' 300 sx; 13 3/8"@ 2005' 54# J-55 1150 sx; 9 5/8"@10,598' 53.50# 1250 sx; 1806' of 7" liner 32# 500 sx	295 B 37.4 10/64"	T 2150 GOR 887	FW. Prod 12,253', Miocene. Deepest form. shale. Piercement salt dome. 60 perf @ 12,243-53'. 114 cores.
12,323	12-22-49 9-29-49	Humble (41-18)2 KCL	Drilling & Exploration Co.	Paloma Kern,Cal	7"@11,543' 1300 sx	Dry		WC. DT 86. Deepest form, Miocene. 6 DS. Bits, rock 77, drag 5.
12,325	5-9-49 3-18-49	Hunt 1-A Grandison	Loffland Bros	Lafourche, La	16"@159'; 10 3/4"@3015'	D&A		WC. Deepest formation, shale.
12,335	5-25-49 1-3-49	Tide Water 24 Hartman		Ventura, Ventura, Cal		843 B 32.4 779 Mcf 20/64"	T 1100	FW
12,336	5-10-49 2-23-49	Western Gulf 54-1 P.U.	Drilling & Exploration Co.	Paloma Kern,Cal	Seamless 7" - 26#, 29#, 32# LT&C	575 B 33 439 cu ft 1/4"	Pkr T 1200 ST 1390 GOR 763	FW. DT 76. Prod 12,333', Stevens, 700' thick. Anticline. 200 perf @ 11,625-12,333'. 275 cores. IR 4115 psi, T 260F, D 10,600', PR 3880 psi. Mud, water base to top sd, oil base to TD.
12,338	9-11-49 4-14-49	Magnolia 3 A.West Heirs	Co.rig	E.Mud Lake Cameron,La	20"@295'; 10 3/4"@4508'; 7"@11,673'	D&A		WC. DT 105. Deepest formation, shale. 40 perf @ 10,690-700'.
12,352	12-17-49 10-14-49	Tide Water 45 Buras Levee	Rowan Drlg Co.	Venice Plaquemines La	20"@200' 66# SJ 350 sx; 13 3/8"@2509' 54.5# SR 1000 sx; 9 5/8"@9500' 40,43,47# SR 1000 sx; 5 1/2"@12,350' 17# SR 1000 sx	374 B 37.9 538 Mcf 5/32"	Pkr T 2450 GOR 1440	Extended field. DT 60, Disc. new sd in miocene, B-45 @ 12,300' & 34' thick. Salt dome. 72 perf @ 12,328-40'. 152 SW cores. Bits, 38 rock.
12,358	8-8-49 12-11-48	Union Oil 1 Govt-Moxa	Brinkerhoff Drlg Co.	Lincoln, Wyo		D&A		WC. 31 cores. Natural mud.
12,360	7-27-49	Tide Water 22 McGonigle		Ventura, Ventura, Cal		889 B 31.7 864 Mcf 20/64"	T 625	Field well.
12,396	10-17-49 4-29-49	G.P.Livermore 1 A.L.Mayhew	Co.rig	Andrews,Tex		D&A		WC. DT 168. Deepest formation, Dolomite. 13 DS tests.
12,417	6-26-49 3-20-49	The Tex. Co.1 Woods Unit (1-1)	Co.rig	Caillou Is. Terrebonne, La	13 3/8"@2010' 300 sx; 8 5/8"@9502' 1000 sx; 5 1/2"@10,125' 185 sx.	238 B 2442 Mcf 11/64"	T 4975 GOR 10,853	WC. DT 82. Prod 9990-10,008', shale and lime. Disc. new sd-extended field. 128 perf @ 9990-10,008'.
12,424	12-16-49 8-4-49	Pure Oil A-1 St. Lse 832	Loffland Bros	Eugene Is. St. Mary,La		107 B 36.8 94 Mcf	GOR 879	WC. DT 90. Disc. new field @ 9643' in Miocene sand, 30' thick. Seismic selection. Salt dome.
12,434	9-26-49 7-13-49	S.W.Richardson-Humble E-6 Morgan City St. 1319		Pointe a la Hach Plaquemines La		317 B 34.2 10/64"	T 1650 GOR 800	FW. Deepest formation, shale. Perf 66/96-10,654. 2 3/8" on pkr @10,626.
12,442	8-20-49 1-3-49	Plymouth B-1 J.B.Wallace	Lee Brown	Benedum Upton,Tex	13 3/8"@300'; 9 5/8"@3632' 2250 sx; 7"@ 9357' 750 sx; 5"@9250-12,442' 300 sx			FW. DT 178. Deepest formation, Ellenburger. Working over.
12,447	9-20-49 7-17-49	Sohio 1 Sevignier Hebert	Roeser & Pendleton	Vermilion, La	16"@65' 42.5# 100 sx; 10 3/4"@2582' 40.5# Istn. 1200 sx; 7"@11,728' 23,26,29&32# Nat'l 800 sx	D&A		WC. DT 63. Deepest formation, sandy shale and sand.
12,450	2-11-49 11-28-48	Humble E-1 La.Furs,Inc	Co.rig 33	Pecan Is. Vermilion, La	7" 12,069' 35# N-80 & 29# N-80 1100 sx Uniflo	135 B 51.3 1/8" 1/4" btm	ST 3600 GOR 29,690	FW. DT 22. Prod 10,675'. Deepest form, Miocene. 42 perf @ 11,997-12,004'; 48 @ 11,898-906'; 54 @ 11,246-50'; 48@ 10,603-11'; 16 @ 10,603-07'. 55 SW cores. 5 DS. D 3'. Bits, rock 13,drag 15.
12,450	8-7-49 3-14-49	Tide Water 75 U.L.W.		Ventura, Ventura, Cal		309 B 32.3 40 Mcf 28/64"	C 1000 T 500	FW
12,458		Quintana 1 McCampbell-Williamson	J.B.Holmes	San Patricio Tex		D&A		WC. Lime base drilling mud.
12,468 11,155	7-26-49	Hunt 1 J.H.Owens,et al		Claiborne La	20"		C 5.5	FW. Deepest formation, Smackover. 2) 9973-10,000 3 M/20 10,020-10,038 M/72

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

*This table includes some late 1948 wells whose descriptions were received too late for last year. Also a few 1949 wells will be listed next year when more detailed descriptions are received.

TABLE 3.—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949.*

TD, ft PB, ft	Compl'd Spudded	Company and name of well	Drilled by	Field, County State	Casing and cementing schedule	Init. prod. grav., choke	Wellhead pressures*	Remarks
12,481	5-31-49 6-20-48	Magnolia 1 4 Leaf Lbr Co.		Vernon, La	20"@105'; 13 3/8"@2500'; 9 5/8"@8,500'; 7"@ 10,362'	D&A		WC. DT 266. Deepest form, shale. Perf @ 5546-52'.
12,485	6-9-49 3-20-49	Arkansas Fuel 1 Cotten Bros.	Loffland Bros	Duck Lake St Martin, La	16" 132' 55# 150 sx; 10 3/4" 2635' 40.5 & 45# J-55 1100 sx; 7" 12,463' 29 & 32# N-80 750 sx; 2 7/8" 11,617' EUE 6.5# J-55 Tbg.	308 B 34 196 Mcf 12/64"	Sealed T 1375 ST 1900 GOR 636	FW. DT 80. Prod, 11,660-66', Miocene "C" sand, 20' thick. Deep seated dome. 48 perf 14 cores. DS 11,680-2'. Bits, 55. IR 5400, T 232 F, PR 5187'.
12,485	2-16-49 6-2-48	Mid-Continent 1 B.U.D.Sawyer	McVay & Stafford	Crossroads Lea, N.Mex	13 3/8" 221' 40# sp. 300 sx; 9 5/8" 4623' 36# 3850 sx; 5 1/2" 12,514' 20# 1000 sx	210 B 44	GOR 487	FW. Prod, 12,380'. Lime. 12 cores, DS 7.
12,500	2-4-49 8-7-48	Gulf 1 La. St. Lse 1304	Loffland Bros	Little Lake Jefferson, La	16" 89' 38 1/2# Lockseam 150 sx; 10 3/4" 2515' 40 1/2# J-55 SS 1000 sx; 7" 10,974' 26# N-80 SS 500 sx; 5" 12,067' 18# N-80 & API 110 sx	Dry		WC. DT 122. Deepest form, shale. 81 cores. Bits, rock 20, drag 24. Natural mud, to lime-starch mud.
12,500	12-19-49 9-19-49	Plymouth 2-48 J.S.Elliott	T & C Drlg Co.	Benedum Upton, Tex	13 3/8"@302' 300 sx; 9 5/8"@3643' 2250 sx; 7"@9875' 1000 sx; 5"@9747-11,435' 200 sx	Flowing		FW. DT 75. Prod, 11,390' Deepest & prod. formation, Ellenburger.
12,500	10-7-49 7-14-49	Plymouth 2-47 E.Gordon	T & C Drlg Co.	Benedum Upton, Tex	13 3/8" 299' 300 sx; 9 5/8" 3675' 2750 sx; 7" 10,722' 1000 sx; 5" 11,375' 90 sx	594 B 58	T 1400 GOR 4765	FW. DT 85. Prod, 11,375. Deepest & prod. formation, Ellenburger.
12,500	9-30-49 3-3-49	Sun 1-1231 State	Loffland Bros	Galveston, Tex	20"@300' 48# Naylor; 13 3/8"@2618' 54.5# J-55, 48# H-40; 9 5/8"@10,246' 40, 43.5,47# S-95-E; 7"@11,127' 23,26# N-80 S-95-E; 5"@ 12,500' 15# N-80.	D&A		Outpost. DT 222. Deepest formation, Frio.
12,512	7-28-49 12-19-48	Humble A-5 Blk 18	Co.rig 36	Gulf-Grand Is., Blk 18 Jefferson, La	5 1/2" 8683' 17 & 15.5# J-55 17# N-80 500 sx Starco	463 B 34.7 351 Mcf	Sealed, T 1320 GOR 437	WC. DT 210 (inc St #1 and hole 2). Disc. new oil zone. Prod, 8621' in Miocene. 105 SW cores. Bits, rock 24, drag 2. 140 perf @8510-45'.
12,522	2-13-49 11-6-48	Tide Water D-4 Manhattan Land & Fruit	Rowan Drlg Co.	Venice Plaquemines La	20" 200' 79.8# slip jt. 300 sx; 13 3/8" 2489' 54.5# J-55 (8-R) 750 sx; 9 5/8" 4002' 40.0# J-55; 9 5/8" 5541' 43.5# S-95 1000 sx; 5 1/2" 6888' 17.0# N-80; 5 1/2" 5599' 17.0# J-55 1000 sx.	338 B 31.8 275 Mcf	Pkr T 2150 GOR 815	FW. DT 78. Prod, 11,281' in Miocene B-6 Sd, 41' thick. Salt dome. 108 perf @ 11,281-11,299'. 149 SW cores. Bits, rock 50.
12,523	8-12-49 5-7-49	Sun 1 Gradnigo Unit "A"	Falcon-Seaboard	Cane Creek Evangeline La	16"@79' 38.5# Naylor; 10 3/4"@2420' 40.5# J-55	D&A		WC. DT 103 days. Deepest formation, Wilcox.
12,525	1-7-49 8-23-48	Humble 1 Atchalafaya Land Co.	Dorris Ballew	Duck Lake St Martin, La	5 1/2" 12,488' 40 & 23# N-80 63# J-55 60 sx Uniflo	273 B 36.2	Sealed T 1050 GOR 751	WC. DT 108. Disc. new oil field @ 11,670' in Miocene. 40 perf @ 11,625-35'. 22 WL, 106 SW cores. 5 DS. Bits, rock 50, drag 20
12,527	1-12-49 2-29-48	Magnolia 1 F.Dodson	George P. Livermore	Chitwood Grady, Okla	20" weld 35' 65.71#; 13 3/8" weld 707' 48#; 9 5/8" 4725' 40#; 9 5/8" 93' 40#; 9 5/8" 368 40#; 7" 11,804' 29#; 5" 623' 1793#.	Temp. Abd.		FW. DT 310 days. 6 cores. 2 DS.
12,542	7-26-49 2-3-49	Plymouth 1 Archbishop of San Antonio	Al Buchanan	Washburn LaSalle, Tex	20" 115' 110 sx; 10 3/4" 4294' 40.5 & 45.5#	Dry		WC. DT 132 days. Deepest formation, Glen Rose. Lime base mud.
12,543 10,218	1-1-49 4-9-48	Richardson & Bass 1 H.F.&A.D.Neal		Upton, Tex		342 B 46.1 2 3/4"	Pkr C 9970 T 550-375 GOR 1552	WC. Dolomite structure. Perf, 180/10,020-050.
12,555	3-30-49 1-15-49	Chicago Corp 1 L.M.Pozzi	Loffland Bros	Iberia, La		D&A		WC. Deepest formation, shale.
12,575	10-29-49 5-27-49	Amerada Rose Eaves	Rowan Drlg Co.	Knowles Lea, N.Mex	16"@280' 63# 245 sx; 10 3/4"@4804' 51# N-80 1550 sx; 7 5/8"@12,574' 34# N-80 800 sx.	883 B 47.9 131 Mcf 1/2"	Pkr T 100 ST 950 GOR 148	FW. DT 155. Prod, Devonian, 100' thick. Anticline. Perf @ 12,530-73'. Bits, 186 rock.
12,576	4-24-49	Wm.Helis 17 Nelson		University E. Baton Rouge, La		166 B 41.7 9/64"	T 1200 GOR 1404	WC. Deepest form, shale. Perf 8068 - 76/32.
12,578	11-26-49 8-31-49	Humble C-1 R.H.Goodrich et al	Co.rig 33	Duck Lake St Martin, La	5 1/2" 12,565' 20# N-80 1700 sx Uniflo	195 B 35.5 146 Mcf	T 2900 GOR 748	FW. DT 55. Prod, 11,741'. Deepest form, Miocene. 12 perf @ 11,831-33'. 99 SW, 54 WL cores. 2 DS. Bits, rock 48, drag 4.
12,580 7,229	10-5-49 4-17-49	Shell 1 Selma Andrews et al	Thompson & Carr	Flanagan Gaines, Tex		Prod.		Deep test. DT 172. Dry hole in Ellenburger, deepest formation. Prod. Lower Clearfork @ 7229'. Bits, 197 rock. Aqua gel and water.
12,583	1-1-49 10-3-48	Continental 3 Pearl R. Jackson	Dillard & Waltermire	Jackson Ranch Chambers, Tex	20" 60' 48#; 13 3/8" 1002' 61# SS; 13 3/8" 635' 54.5# SS 800 sx; 9 5/8" 415' 53.5# SS; 9 5/8" 998' 47# SS; 9 5/8" 2815' 43.5# SS; 9 5/8" 4835' 40# 1000 sx	D&A		WC. DT 91. Deepest form, Frio. Faulted anticline. Bits, rock 24, drag 18. Natural mud (Baroid) to 8900', then starch-impermex.
12,591	11-16-49 6-23-49	Hiawatha 1 Mayer H.Halff		Benedum Upton, Tex		P&A		FW. Dolomite structure. Perf, 160/11,970-12,010 A-2000. DS, 12,186-520.
12,592	6-3-49	T.W.McGuire, et al 10 McDonald		Lisbon Claiborne, La		D&A		WC. Formerly United Gas Co. well. Tested in shallower zones to 5200'.
12,593	7-24-49 6-12-49	The Tex.Co. 7 St. Lse 340 Atchalafaya Bay	Co. rig	Belle Is. St. Mary, La	13 3/8"@1981' 650 sx; 9 5/8"@10,100' 1250 sx; 6 5/8"@10,892' 210 sx.	P&A		WC. Deepest form, sd.
12,601	6-14-49 4-18-49	Humble F-1 La.Furs	Co.rig 33	Pecan Is. Vermilion, La	13 3/8" 2004' 61# J-55 485 sx Trinity	Dry		WC. DT 54. Deepest form, Miocene. 86 SW cores. Bits, rock 13, drag 16.
12,607	10-6-49 12-26-48	Amerada 1 Stella B.Rose	McVay & Stafford	Knowles Lea, N.Mex	13 3/8"@273' 35# 225 sx; 8 5/8"@4825' 32# J-55 600 sx; 5 1/2"@12,596' 70# J-55 600 sx	397 B 47.1 73 Mcf 1"	Pkr. T 65 ST 200 GOR 184	FW. DT 168. Deepest & prod form, Devonian, 150' thick. Anticline. Open hole 8596 to 12,607'. 3 cores. DS 12,560-597'.
12,610	10-6-49 6-10-49	Amerada 1 B.T.Pheasant	Noble Drlg	Reno Hill Johnson, Wyo	10 3/4"@791' 45# J-55 400 sx	D&A		WC. DT 118. Deepest formation, Benton-Upper Cret. 1 core.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

*Table includes some 1948 wells whose data were received too late; a few 1949 wells are held over for more details.

TABLE 3—CONCLUDED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949*

TD, ft PB, ft	Complt'd Spudded	Company and name of well	Drilled by	Field, County State	Casing and cementing schedule	Init. prod., grav., choke	Wellhead pressures	Remarks
12,610	2-6-49 9-12-48	The Tex.Co. 1 Newton Lbr Co.	Danciger	Newton,Tex		43 B 44° 10/64"	Sld T 300 GOR 2735	WC. New field, seismic selection. Prod, 9650', Wilcox, 15' thick. Anticlinal. Perf 6' jet @ 9644-60'.
12,626	6-1-49 8-1-48	Phillips 1 Shipp	Co.rig	Hobbs Lea,N.Mex		Dry & Plugged		WC. DT 263 days. Deepest formation, lime, sand, & chert.
12,642	3-31-49 10-23-48	Pure Oil 1 Fee	Carl Short	Chacahoula Lafourche, La		42 B 48.4° 3514 cu ft	GOR 83,690	Extend field. DT 120. Prod, 9879', Lyric sand, 14' thick. Deepest, shale. Salt dome.
12,656	5-6-49 10-4-48	Amerada 1 Hamilton	Rowan Drlg	Knowles Lea,N.Mex	13 3/8"@250' 55# J-55; 8 5/8"@5100' 32# J-55; 5 1/2"@12,508' 17# J-55 800 sx	935 B 46.9 169 Mcf	GOR 180	WC. DT 219. Disc. new field. Seismic selection. Prod, 12,518-600', Devonian-lime, 200' thick. Anticline. Open hole @ 12,518-600'. 21 DS. IR 5124 psi, D 12,494', PR 5120 psi. Bits, rock 191.
12,657	9-15-49 2-21-49	Oil Development 1, Santa Fe Pacific	George P. Livermore	Lea,N.Mex	15" 300' 850 sx; 9 5/8" 4664' 40# 2400 sx; 7" 10,794' 32,29&26# N-80 800 sx	Dry		Semi-WC. Deepest formation, Devonian. DS 9595-9648', 12,606-657'. Bits, 203 rock.
12,692	1-25-50 10-1-49	The Tex. Co.A-9 St. Lse 1217 Bay de Chene	R.H.Gracey & Co.	Bay de Chene Jefferson, La	13 3/8"@2544' 500 sx; 8 5/8"@11,175' 1000 sx; 5 1/2"@12,692 375 sx.	135 B 5728 Mcf 1/4"	GOR 42,438	FW. DT 83. Prod, 10,670-84', sand.
12,707	4-5-49 1-10-49	Union-Cal. B-2 St. Lse 540	R.H.Gracey & Co.	W.White L. Vermilion, La	16" cond @156' 150 sx; 10 3/4"@2623' 40.5# H-40 & J-55 1400 sx	D&A		Semi-WC. Deepest formation, sand. Bits 31. Mud, phosphate.
12,731	3-11-49 10-23-48	Shell 2 Weeks Island Unit "A"		Weeks Is. Iberia,La	16" 120'; 10 3/4" 4508'; 7" 12,403'	432 B 34° 401 Mcf 11/64"	T 2100 GOR 928	FW. DT 92. Prod, 12,180', "R" Sd, 34' thick. Deepest form, sandy shale. 40 perf @ 12,170-80'.
12,733	5-4-49 10-28-48	General Pet. KCL-Calder 38-23	Co.rig	Calder Kern,Cal	7"@8715' 23 & 26# T&C. Scratchers and equalizers used. 89' of 5 1/2" liner.	154 B 34.5° 202 Mcf 1/2"	Pkr. T 620 GOR 1312	WC. DT 150. Disc. new field, 8815-35', Stevens, upper miocene 40' thick. Anticline (?). Seismic data. 100" x 2" slots, 20 rows perf 8808-8834'. 39 cores. DS 3. Did not flow. IR 3400 psi. Bits, 133 rock. Emulsion-type mud.
12,740	3-9-49	Tide Water 62 UL&W		Ventura Ventura, Cal		749 B 34.1° 586 Mcf 20/64"	C 100 T 1000	
12,749	3-29-49 10-20-48	Union Prod. 2 St. Bay Baptiste Unit	Loffland Bros	Bay Baptiste Terrebonne La	16" 151' 55.00#; 10 3/4" 2996' 51# 1200 sx; 7" 11,429' 29# 1150 sx.	4200 B 15,000 Mcf 1/4"	ST 3373	Field extension. DT 88. Prod, 8955-68', 104 perf, Miocene sd. Deep seated salt dome. 11 DS.
12,783	7-8-49 4-10-49	Lloyd 30	Drilling & Exploration Co.	Ventura Ventura, Cal	13 3/8" 1260' 54,61 & 68# 1200 sx; 7 5/8" 12,000' 33 & 39# 1500 sx; 5" 11,945-12,783' 18 & 35.4# 75 sx.	Flowing		FW. DT 90. Prod, 12,180'-783', Repetto. Est. thickness, 5000'+?. Anticline.
12,832	6-27-49 2-19-49	S.W.Richardson 1 Ada Miller Soileau		Evangeline, La		85 B 51° 800 Mcf 7/32"	T 2600- 2800 GOR 5235	Deep test. Deepest form, sandy shale. 2 3/8" perf @ 11,295'.
12,851	4-12-49 12-27-48	Superior 1 Turtle Bayou St.Lse 1612	Hillburn Drlg	L.De Cade Terrebonne, La	18"@131' 200 sx; 13 3/8"@2073' 54.50# J-55 1200 sx; 9 5/8"@11,219' 54# N-80 1000 sx	D&A		WC. Deepest formation, shale.
12,872	10-13-49 3-17-49	Magnolia 2 Roy Glass	Co.rig	Pegasus Midland,Tex	13 3/8" 454' 48#; 9 5/8" 5122' 40#; 7 5/8" 9100' 34#; 5 1/2" 12,745' 20#.	932 B 46.2° 1/2"		FW. DT 194. Prod, 12,745'. Deepest form, dolomite. DS 12,832-872'.
12,874	4-10-49 12-11-48	The Tex. Co. 1 St.Lse 1217 Bay de Chene A-7	R.H.Gracey & Co.	Bay de Chene Jefferson, La	13 3/8"@1980' 500 sx; 8 5/8"@11,032' 1000 sx.	P&A		WC. DT 114.
12,906	3-28-49 11-16-48	Amerada 1 Foster Lbr	Dillard & Waltermire, Inc.	Fostoria Montgomery, Tex	16"@175' 65# H-40; 10 3/4"@3911' 40# J-55	D&A		WC. DT 132 days. Bits, 73 rock.
12,932	4-24-49 1-5-49	The Tex. Co. 9 St. Lse 329 St. Mary Ld Co.	Co.Drlg. Dge.	Horseshoe Bayou St Mary,La	13 3/8"@1940' 700 sx; 8 5/8"@12,375' 1000 sx.	291 B 33.3° corr. X-34	T 1910 GOR 1329	FW. DT 90. Extension to sand. Prod, 12,020-24', sandy shale & lime.
12,932	8-28-49 5-31-49	Union Prod. 1 St.Lse 1587 Lake Salvador		L.Salvador Jefferson, La	16" 107' 55#; 10 3/4" 2977' 40.5# 1000 sx; 7" 11,399' 29# 1200 sx.	D&A		WC. DT 77 days. Deepest formation,(shale) miocene. 2 DS.
12,950	12-24-48 3-31-48	British Am. 1 Hartmann- Barnard Unit	Rocky Mtn. Drlg Co.	Ventura Ventura, Cal	N-80 Youngstown high drill 8 5/8" casing in 7 sections using 36, 40 & 44 # 11,725' 1500 sx	234 B 30.1° 17/64"	C 275 GOR 800	FW. DT 122. Development well D-7 zone. Prod, 10,210-977, D-6. Deepest formation, D-7 zone Pliocene. Anticline. Perf, BJ Perfojet 1,828 1/2" holes over 842'.
12,954	8-22-49 9-4-47	Standard-Cal 4-2 SP&FL	Loffland Bros	Lost Hills Kern,Cal	16"@1360'; 9 5/8" 9396'; 6 5/8" 12,286'; 759' of 4 1/2" @12,951'; CP 12,785'	D&A		WC. DT 486. Redrilled. 4 1/2" perf @ intervals 7777'-12,951'. Mud, water base, lime impermex, red lime.
12,984	12-9-48 4-30-48	Gulf Oil 1 S.S.Perry, S.F.Austin A-20	Nichlos Drlg Co.	Peach Point Brazoria, Tex	20" Sp. 104' 48# 180 sx; 13 3/8" 3408' 54 1/2 & 61# S-80 2400 sx; 9 5/8" Hyd. 7125' 43 1/2 & 47# 800 sx; 7" 10,844' 26# N-80 550 sx; 5" 11,431' 18# N-80 150 sx.	34.4 B 44.2° 4,255 Mcf 3/16"	T 7890 ST 8100 GOR 123,919	WC. DT 200. Prod, 11,348', lower Frio. Deepest form, shale. Faulting structure. 280 jet perf @ 11,278-348'. 122 cores. Est. IR 9530 psi, T 225 F, D -11,293', Est PR 9145 psi. Bits, rock 22, drag 49. Natural mud changed to Silicate mud.
12,995	5-11-49 10-30-48	Ohio Oil Co. KCL-A 61-31	Co.tools	Paloma Kern,Cal	18" condr. 43'; 13 3/8" 1427' 54.5# 1100 sx; 7" 10,348' 26 & 29# Bro. L.T.S.C. N-80 1200 sx; 713' set at 10,981' alum liner 5.41# 90 sx	D&A		FW. DT 191. Deepest formation, Paloma Sd. Stratigraphic trap on anticlinal dome. 119 cores. Perf: 4-1/2" holes in 7" csg. @ 10,310', 4-1/2"/ft @ 10,543-563', 2 1/4" x 3/32" slots, 5 rows @ 10,882-981'. Water base & oil base mud.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

*Note: For the first time the survey this year included mud systems or programs and their cost. Some of the replies are included under remarks.

TABLE 3.—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949.

TD,ft PB,ft	Complt'd Spudded	Company and name of well	Drilled by	Field,County State	Casing and cementing schedule	Init.prod., grav.,choke	Wellhead pressures*	Remarks
13,000	12-10-49 9-7-49	The Tex.Co. 7 City of N.O.	Wheless Drlg Co.	Leeville Lafourche, La	13 3/8"@2893' 500 sx; 9 5/8"@12,000' 1000 sx	P&A		WC. DT 79 days.
13,000	10-7-48 4-12-48	Stanolind 1-A Buckner Orphans Home	Co.rig	Matagorda, Tex	20"@82'; 13 3/8"@1205' 1200 sx; 9 5/8"@ 6984' 1000 sx; 7"@10,997' 900 sx	D&A		WC. DT 176 days. Dry hole. Deepest formation, Vicksbg.
13,001	7-17-49 3-22-49	The Tex.Co. 2 Lutcher-Moore	Danciger	E.Cameron Cameron,La	11 3/4"@1886' 500 sx; 7 5/8"@12,104' 1000 sx.	Abandoned		WC. DT 73. Deepest formation, shale.
13,005	11-18-49 8-21-49	The Tex. Co. & Placid St. LLAE Unit 2-1		Lake Washington Plaquemines La	13 3/8"@2988' 1200 sx; 7 5/8"@11,651' 1000 sx; 5"@11,445-13,005' 225 sx.	D&A		FW. Deepest formation, shale.
13,010	5-20-49 2-27-49	Humble 1 F.Buttram	Danciger	Freetown St Mary,La	9 5/8" 9501' 40 & 43.5# N-80 500 sx Uniflo	Dry		WC. DT 75. Deepest form, Discorbis, 85 SW cores. Bits, rock 51, drag 2.
13,021	10-15-49 7-15-49	The Tex. Co. St.Lse 199	Co. Drlg. Dge.	Bay St. Elaine Terrebonne, La	10 3/4"@2941' 500 sx; 7"@12,506' 1000 sx.	Temp. Abd.		WC. DT 86. Deepest formation, shale.
13,033	1-24-49 4-30-48	Mtn.Fuel Supply 5 Unit	Delta Drlg.	Church Buttes Sweetwater Wyo.	16"@287' 70# DBX 275 sx; 10 3/4"@6590' 55 & 51# Smls. J-55 & N-80 2850 sx; 7"@12,766' 26,29 & 32# N-80 LT&C&XL 2500 sx.	Shut-in		Semi WC. DT 217. Prod, 13,033' in Dakota, 225' thick. Deepest formation, Fuson shale. Anticline. Slotted liner set at 13,031'. 16 cores. Bits, rock 171. Water base mud to 12,770', oil base to TD.
13,050	3-21-49 9-19-48	Tide Water 1 St Lse 1299	Rowan Drlg	Manila Village Jefferson, La	20" 80' 66.2# Wall PE Nat'l 250 sx; 13 3/8" 2482' 54.5# J-55 8R 800 sx; 9 5/8" 5540' 43.5# S-95 8R; 9 5/8" 2512' 40.0# J-55 8R; 9 5/8" 978' 43.5# N-80 8R 1000 sx; 7" 4030' 31.68# N-80 Hyd.; 7" 8501' 29.0# N-80 8R 1000 sx; 5" 765' 18.0# N-80 Ext.line 85 sx.	179 B 39 934 Mcf 6/64"	Sealed T 8050 GOR 5218	WC. DT 125. Disc. new field 12,985-13,007' in miocene sd, 22' thick. Deepest form, shale & sd. Site selected by geophysics. 92 SW cores. IR Est over 12,600 psi. Bits, rock 75.
13,123	6-28-49 11-5-48	Amerada 1-CA State	Creekmore Drlg Co.	S.Marshall Lea,N.Mex	13 3/8"@250' 55# J-55; 8 5/8"@4200' 36# J-55	D&A		WC. DT, 239. Deepest formation,Ellenburger. Bits, rock 202.
13,125	10-27-49 5-6-49	Republic Nat. Gas 1 Powell	Norwood Drlg Co.	Pegasus Upton,Tex	13 3/8"@315'; 9 5/8"@4681'; 7"@12,945'.	638 B 3/4"	T 750 GOR 1.450	Semi-WC. DT 165. Extend field. Prod, 12,945', Ellenburger 284' thick. Anticline. 9 DS. Rock bits 145.
13,150	7-28-49 12-11-48	Phillips 1-A Daw,Wm.Moore	Co.tools	Chambers,Tex		D		WC. DT 145. Deepest formation, sandy shale.
13,186	6-10-49 2-10-49	Stanolind 15 Am.Warehouse	Noble Drlg	Cedar Lake Gaines,Tex	13"@214'; 9 5/8"@5058'.	D		Workover deepened from 11,954-13,186'. Dry hole in lower form.
13,192	9-6-49 6-9-49	Humble 1 Atchalafaya Basin Levee Bd	Hillburn Drlg	Duck Lake St Martin, La	9 5/8" 7538' 40 & 43.5# N-80 & J-55 750 sx Uniflo	D		FW. DT 81. Deepest formation, Miocene. 70 SW cores. Bits, rock 51, drag 17.
13,212	9-3-49 8-31-48	Union Producing 1-A,Music	Helmerich & Payne	Elk City, Beckham, Okla	16" 123' 65# H-8 140 sx; 10 3/4" 2644' 40.50# J-55 250 sx; 7" 10,512' 29# N-80 400 sx; 5" 2707' 18# N-80 300 sx. 5" liner @ 13,009'.	332 B	C 2225 T 2255 GOR 6600	FW. DT 305. 78 perf @ 8915-25', Pennsylvanian. Anticline. DS 26.
13,214	6-26-49 3-31-49	Humble 1 St Lse 1602	Co.rig 29	L.Palourde Assumption La	9 5/8" 9528' 40 & 43.5# N-80 & S-95 500 sx	D		WC. DT 65. 10 perf@ 1816-21', Miocene. 77 WL, 3 SW cores. Bits, rock 52, drag 14.
13,226	11-1-49 5-9-48	British Am. 1 Federal O'Donnel Whiskey Peak	Brinkerhoff Drlg. & Exploration Drlg.	Whiskey Peak Prospect Fremont,Wyo	13 3/8" surface casing 10 sx; 9 5/8" pulled when well was plugged and abandoned	D		WC. DT 215. Site selected by geophysics. Deepest formation, Lakota. Anticline. 14 cores.
13,228	9-21-49 2-1-49	Humble X-1 N.Mex St.	C.B.King	Four Lakes Lea,N.Mex.	13 3/8" 300' 32.4# Naylor 300 sx; 5 1/2" 10,088' 17# N-80 & 15.5# J-55 350 sx.	D		WC. DT 204. 220 perf @ 10,050-60, 9955-75, 9600-25', Devonian. 8 SW, 1 Con cores. 15 DS. Rock bits 253.
13,232	1-11-50 8-2-49	Gulf 1 Maude Saunders	Parker Drlg Co	Lea,N.Mex	13 3/8"@327' 48# 350 sx; 9 5/8"@4197' 36# (117 jt.) & 40# (11 jt.) 1800 sx; 7"@10,759' 23# (121 jt.), 26# (75 jt.) & 29# (58 jt.) 800 sx.	992 B 42.7 1479 Mcf 2"	T 100 GOR 1490	WC. DT 153. Discovered new field, site selected by geophysics. 70 perf@ 9865-82½', Mississippian, approx. 60' of variable porosity. Anticlinal. 7 cores. T 192F D 13,218'. Rock bits 191. Fresh water base
13,254	8-29-49 1-13-49	Amerada 1 Smiths Cut	Parker Drlg	Smiths Cut Johnson,Wyo	16"@514' 55# 400 sx; 10 3/4"@6002' 45# J-55 1500 sx.	D&A		WC. DT 219. Deepest formation, Lakota. 6 cores.
13,260	4-14-49 6-22-48	Gulf 1 Merment au Min & Land Co.	Prince Drlg	Little Chenier, Cameron,Wyo	20" 48# 250 sx; 13 3/8" 61 & 54.50# 1000 sx; 9 5/8" 47 & 43.50# 1000 sx, 7" 25.66 liner.	D		WC. DT 243. 120 perf in 5 sections, 10,416-28', sand and shale. Bits, rock 55, drag 19. Natural mud, converted to lime-starch mud. High pressures and lost circulation problems.
13,271	3-24-49 7-16-48	Magnolia 1 W.C.Hicks	J.S.Abercrombie	Gaines,Tex	13 3/8"@354'; 9 5/8"@5892'	D&A		WC. DT 227. Dolomite. DS 13,100-130.
13,282	8-22-49 7-7-48	Phillips & Kerr-McGee 1-A St Lse 1123 Blk 33	Kerr-McGee	In Gulf (W.Cameron) Cameron,La	5 1/2"@12,568' 600 sx.	934 B 42.3 428 Mcf 14/64"	C:packed T 1700 GOR 459	WC. DT 310. 80 perf @ 10,390-408', lower miocene, 11' thick, seismic closure. Disc new field, site selected by seismograph.
13,295 12,825	3-15-49 4-5-48	Magnolia 1-A TXL	Co.rig	Pegasus Upton,Tex	13 3/8" 423' 48#; 9 5/8" 8902' 47#; 7" 13,087' 32#	1167 B in 24 hr 52.3 3/4"	T 300 GOR 1403	WC. DT 281. New Ellenburger disc. Prod, 12,700'. 8 cores. DS 12,694-755.
13,310	7-18-49	Spartan A-1 P.C.Authement		Golden Meadows Lafourche, La		10/64"		WC. Deepest formation, salt. Perf, 10,716-10 - 720/24.
13,311	11-14-49 6-26-49	Sohio-Sun D-1 Miami Corp	Danciger	Cameron,La	16" 20' 38.5# Naylor sp. weld 150 sx; 10 3/4" 2531' 40.5# Youngstown seamless 1200 sx; 7" 10,867' 23,26,29 & 32# Nat. seamless 1000 sx.	D&A		WC. Deepest formation, shale.
13,317	11-13-49 8-1-49	The Tex.Co. St Lse 1464 Cockrell Unit 1 (2-1)		Lake Washington Plaquemines La	13 3/8"@1432' 350 sx; 8 5/8"@9976' 1000 sx.	D,P, &A		WC. DT 99.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. Producer flowing unless otherwise stated.

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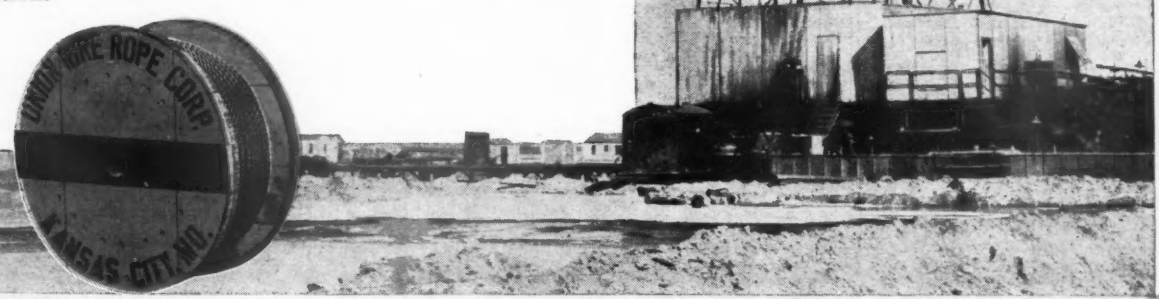

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TABLE 3.—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949. *

TD,ft PB,ft	Complt'd Spudded	Company and name of well	Drilled by	Field, County,State	Casing and cementing schedule	Init.prod., grav.,choke	Wellhead pressures*	Remarks
13,321	11-21-49 3-12-49	Stanolind 1 Canyon Creek	Brinker-hoff Drlg	Canyon Creek Sweetwater, Wyo	13 3/8"@1055' 800 sx; 7"@12,651' 1050 sx; 5"@12,541-13,185' 125 sx.	D		WC. DT 264. Deepest formation, Dakota. Rock bits 175. Bentonite base mud.
13,325	9-23-49 7-16-49	Shell B-6 Smith-State		Weeks Island Iberia, La	16" 127'; 10 3/4" 4502' 7 5/8" 13,326'.	324 B 33 344 Mcf 10/64"	T 2500 GOR 1062	FW. DT 63. 60 perf @ 13,205-20', "R" sd, 50' thick. Deepest form, shale. Bits, 52.
13,350	10-27-48 5-25-48	Lloyd 25	Drilling & Exploration Co.	Ventura, Ventura,Cal	13 3/8" 1008' 54# 900 sx; 7 5/8" 11,883' 33.7 & 39# 1500 sx; 5" 12,830-13,350' 18#	Oil & gas		FW. DT 123. Prod, 12,353-13,350, Repetto, 5,000 ± ? thick. Anticline. Perf, 20/ft 1/4" diam. @ 12,353-13,350.
13,369	10-9-49 4-7-49	Humble A-2 Blk 34, St. Lse 1034.	Co.rig 40	S.Timbalier, Blk 34 in Gulf-Ship Shoal Blk 72	9 5/8" 294 jt. 650 sx.	D		WC. DT 126. 31 perf @ 2824-3789', miocene, 120 cores. D 24.9. Bits, rock 21, drag 5.
13,374	3-16-49 4-24-48	The Tex.Co. 1 C.Scharbouse, et al	Gardner Bros.	Warfield Andrews,Tex	13 3/8" 325' 290 sx; 9 5/8" 5068' 2800 sx; 5 1/2" 13,360' 250 sx	44 B 46.9 30.2 Mcf 25/64"	C 1200-1490 T 575-700 GOR 687	WC. DT 210. New field, geophysical selection. Prod, 13,049, Ellenburger. Anticline 489 1/2" perf @ 13,130-049'. 23 DS. IR 5335 psi, D 12,000'.
13,378	7-1-49 10-16-48	Mountain Fuel Unit 6	San Joa-quin Drlg	Church Buttes Unita and Sweetwater, Wyo	13 3/8"@307' 61# Smls 220 sx; 9 5/8"@6720' 40&43.5# Smls 1900 sx; 6 5/8"@13,352' 24,28,& 32# LT&C&XL 700 sx	D		Semi-WC. DT 202. Drlg. temporarily suspended. Deepest form, Morrison. Anticline. 34 cores. Rock bits 219. Water base to 12,918', oil base to TD.
13,383	9-17-49 6-6-49	Union Pro. St Lse 1582	Loffland Bros.	L.Raccourci Lafourche,La	16" 99' 55#; 10 3/4" 2976' 40.50# 1000 sx; 7" 11,495' 29 & 26# 1000 sx.	44.3 B 17,600 Mcf 1/4"	ST 394	FW. DT 95. 12 perf @ 10,430-435', miocene. 2 DS.
13,396	4-20-49 7-2-48	Hunt 1 A.B.Henican	Loffland Bros.	Plumb Island Terrebonne, La	16"@90'; 10 3/4"@2515'; 7"@11,750'.	D&A		WC. Deepest formation, shale.
13,421 9,248	6-15-49 1-12-48	Ohio Oil 3 Sledge	Co.tools	Knox Grady,Okla	17 1/4" 47' 35 sx; 13 3/8" 997' 1000 sx; 7" 12,283' 26,29,& 32# N-80-XL 50 sx.	37 B 2,246 Mcf 1/2"	C 800 SC 3250	WC. 110 perf @ 8910-9300'. Deepest form, Springer (Penn.). Faulted anticline. Site selected by seismograph and subsurface data. Produced some gas but not commercial. Being abandoned. Water base Drisco.
13,447	2-8-49 11-6-47	Stanolind 1 Sand Coulee Unit	Kerr-McGee	Big Sand Coulee Park, Wyo	20"@109'; 13 3/8"@1229'			WC. DT 424. Deepest form, Madison. Bits, rock 195, Dia 16. Bentonite and red lime.
13,484	6-2-49 1-28-49	Humble 1-A St Lse 809 Quatre Bayou, Blk 12	Co.rig 42	W.Delta Area G.of Mexico Plaquemines, La	9 5/8" 9639' 40 & 43.5# S-95 & N-80 650 sx	D		WC. DT 89. Deepest form, miocene. 137 SW cores. Bits, rock 6, drag 39.
13,509	10-20-49 2-11-49	Shell 1 Baldwin Hills	Co.tools	E.Inglewood Los Ang.,Cal	10 3/4" 3499' 1000 sx; 7" 11,726' 600 sx	D&A		WC. DT 215. Deepest form, miocene. 110 cores. 1 DS. Rock bits 217. Clay base mud.
13,540	10-1-49 4-29-49	Superior 1 LL&E St.Unit 9	Co.rig	Four Isle Terrebonne,La	18"@128' 250 sx; 13 3/8"@2036' 54# J-55 800 sx; 9 5/8"@10,962' 53.50# 1250 sx; 7" 12,720' 29 & 35# N-80 500 sx.	145 B 46.9 4280 Mcf 16/64"	T 3785 GOR 29,315	FW. 48 perf @ 12,075-105' in Miocene. Piercement type dome. 54 cores.
13,541 7,800	3-27-49	Union Oil 107 Bell	K.L.Kellogg & Sons	Santa Fe Spgs Los Ang.,Cal		Oil		FW. DT 207. Fresh water mud to 5000', calcium chloride below. Intended as deep well but due to fishing job was completed as normal FW.
13,575	10-6-49 7-14-49	Shell 5 Smith St Unit 1		Weeks Island Iberia,La	16" 121'; 10 3/4" 4457'; 7 5/8" 13,574'	420 B 34 453 Mcf 11/64"	T 2650 GOR 1079	FW. DT 86. 60 perf @ 13,505-520', "R" sd, 44' thick. Deepest form, sandy shale. 55 bits.
13,578	2-13-49 7-31-48	Standard-Cal. 12-21 KCL	Co.rig	Greeley Kern,Cal	20" 29'; 13 3/8" 1485'; 7" 13,346' CP 10,520 & 10,690'. Plug 10,670-690'.	85 B 26.8 56 Mcf	GOR 659	WC. DT 170. Disc. new sd. 4 - 1/2" perf/ft @ 10,530-605', miocene. Deepest form, Eocene. Anticline structure. Water base mud. Gun perf in oil base.
13,588 9,210	10-7-49 12-5-48	Stanolind D-2 Cities Service E.F.Cowden	Gardner Bros	Addis Ector,Tex	13 3/8"@211'; 9 5/8"@3940'; 5 1/2"@9180'	205 B 16/64"		WC. DT 295. Deepest form, Ellenburger. Rock bits 222. Used water and salt starch.
13,594	7-16-49 2-14-49	Hunt 1,Goodrich St Lse 1329		Duck Lake St Martin,La	7" & 5" liner all cemented	102,000 Mcf 1/4"		WC. Disc. gas field. Perf @ 12,404-07', Prod. sd,60' thick. Deepest form, shale. IR 4100 psi.
13,614	10-13-49 12-20-48	Standard-Cal 27-6 KCL	K.L.Kellogg & Sons	Button Willow Kern,Cal	20" 28'; 13 3/8" 1501'; 9 5/8" 5780', all cemented. Plug 4765; WSO 3340.	Shut-in		WC. DT 255. 4 1/2" perf/ft @ 3403-13'. Disc. shallow pool. 10' thick, strat. trap anticline. Emulsion base mud used.
13,669	3-29-49 11-15-48	Lloyd 26	Drilling & Exploration	Ventura Ventura,Cal	13 3/8" 1240' 54# 900 sx; 7 5/8" 12,125' 33 & 39# 1500 sx; 5" 12,051-13,669' 18# 100 sx	Oil & gas		FW. DT 132. 20/ft 1/4" @ 12,800-13,669' Repetto, 5000'. Anticline.
13,691 5,000	5-2-49 10-18-48	Amerada 1 H.A.Godejohn	Dillard & Waltermire	Fostoria Montgomery, Tex	16"@175' 65# H-40; 9 5/8"@2600' 32# H-40; 5 1/2"@13,500' 20# N-80 1500 sx.	Gas		WC. DT 205. Disc. shallow gas field. Geophysics selection. Deepest form, sandy shale. Tested below 12,010' to TD.
13,693	12-29-49 9-2-49	Humble 1 St Lse 1706	Co.rig 26	W. Cote Blanche Bay Iberia,La		Gas		WC. DT 27. Disc. gas field @ 10,020'. Deepest form, miocene. Bits, rock 47, drag 5.
13,706	6-26-49	Tide Water 27 McGonigle		Ventura Ventura,Cal		774 B 32.4 647 Mcf 20/64"	C 300 T 1100	FW in Ventura Avenue field, one of most prolific deep fields.
13,770	4-25-49 11-12-48	Lloyd 27	Drilling & Exploration	Ventura Ventura,Cal	13 3/8" 1280' 54.5# 945 sx; 7 5/8" 12,094' 33 & 39# 1500 sx; 5" 12,017-13,770' 18# 125 sx.	Oil & gas		FW. DT 114. Perf. 20/ft 1/4" @ 12,814-13,770', Repetto, 5000 ± (?) thick. Anticline.
13,791	6-4-49 11-7-48	Seaboard-Del.1 M.S.Doss	W.H.Black Drlg Co.	Gaines,Tex	13 3/8" 300'; 9 5/8" 4700'.	Dry		WC. DT 207. Deepest formation, Ellenburger. 5 DS. Rock bits 220.
13,818	1-28-49 5-11-48	Ohio 1 Mitchell	Co.tools	Lamont-Comanche Pt. Kern,Cal	18" 54' 70.59#; 13 3/8" 1432' 61# 1000 sx; 7" 12,800' 26 & 29# 8-R LT&C, 32 & 35# N-80 2000 sx; 5" liner 13,471' 15# 100 sx	D&A		WC. 40 perf @ 12,765'-13,160'. Deepest form, basement. Fault and stratigraphic trap structure. Water base mud.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. DS-drillstem test. Producer flowing unless otherwise stated.

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Churchill Downs on May 17, 1875 was the site of the first running of the Kentucky Derby. Here, the winner of the "Run for the Roses" receives the floral horseshoe symbolic of victory. The 76th running is scheduled for the first Saturday in May at Louisville, Kentucky.

For more than half a century, Jones sucker rods have been noted for their ability to lift loads successfully under conditions of shock, abrasion, strain and corrosion that have spelled premature failure for lesser rods and couplings.

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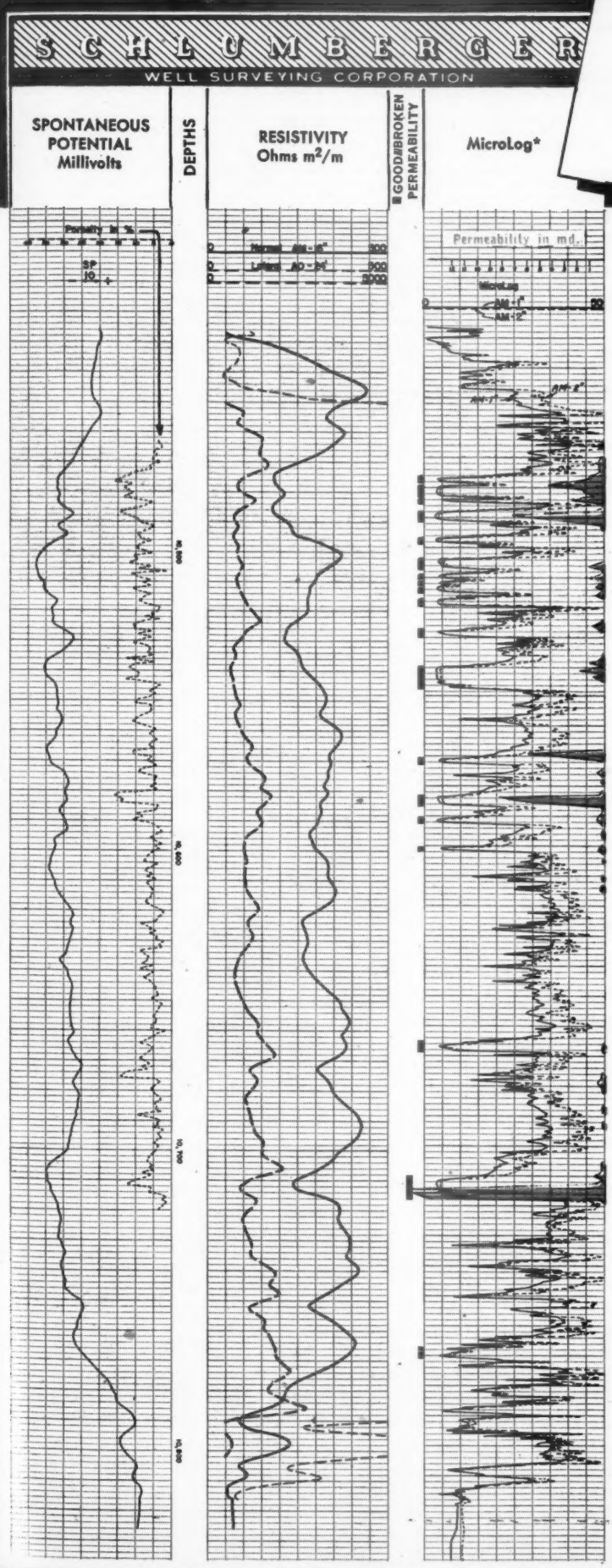
TABLE 3.—CONTINUED. DESCRIPTION OF WELLS DRILLED BELOW 12,000 FT IN 1949.

TD,ft PB,ft	Complt'd Spudded	Company and name of well	Drilled by	Field, County,State	Casing and cementing schedule	Init.prod., grav.,choke	Wellhead pressures*	Remarks
13,820	2-25-49 8-4-48	The Tex.Co. 6 City of N. O.	O.W.Dyer	Leeville Lafourche,La	13 3/8"@2632' 500 sx; 8 5/8"@11,990' 780 sx.	92 B 48.9 @ 60 8/64"	T 4250 GOR 8372	FW. DT 129. Prod, 13,360-410'. New sd & ext. to fld.
13,822	2-28-49 3-19-48	Gulf 1 E.W.Bryant	Rowan Drlg.	Midland,Tex	13 3/8" 255' N-S Gr. H-40 350 sx; 9 5/8" 5070' 40# N-S Gr. N-80 3000 sx; 7" 2449' 29# SS N-80; 3837' 26# N-80; 7930' 26#; 11,114' 29# J&L S. N-80; 5" 10,993'-12,796' 18# N-80 450 sx.	Dry		WC. DT 346. Deepest form, Ellenburger. 5 cores. 24 DS. Rock bits 226. Open fresh water mud system.
13,839	6-26-49 12-3-48	Shell C-2 Smith-State		Weeks Island Iberia,La	16" 120'; 10 3/4" 4530'; 7 5/8" 12,960'; 5" 13,837'.	378 B 34 420 Mcf 9/64"	T 2550 GOR 1112	FW. DT 195. 60 perf @ 13,728-63', "R" sand, 90' thick. 136 bits.
13,850	8-20-49 5-8-49	Lloyd 28	Drilling & Exploration	Ventura Ventura,Cal	13 3/8" 1219' 54.5# 1000 sx; 7 5/8" 12,212' 33 & 39# 1500 sx; 5" 12,149-13,850' 18# 100 sx.	Oil & gas		FW. DT 104. Perf. 20/ft 1/4" @ 12,858-13,850', Repetto, 5000' ∠ (?). Anticline.
13,880	1-10-50 5-9-49	Magnolia B-1 Blk 58,No.673	Co.rig	Terrebonne,La	18"@538'; 13 3/8"@2990'; 9 5/8"@9005'; 7" @12,644'.	8000 Mcf 7/64"	SC 3727	WC. DT 177. Disc. gas field, 11,206-8'. Deepest form, shale. DS 13,324-29.
13,907	11-1-48 6-12-48	Lloyd 24	Drilling & Exploration	Ventura Ventura,Cal	13 3/8" 1008' 54.5# 850 sx; 7 5/8" 12,371' 33 & 39# 1500 sx; 5" 12,315-13,907' 18#	Oil & gas		FW. DT 110. Perf. 20/ft 1/4" @ 12,798-13,907', Repetto, 5000' ∠ (?). Anticline.
13,956		Quintana L J.H.Harvey	Bilbo- Redding	San Patricio, Tex		Dry		WC. Lime base mud used.
13,968	12-4-48 9-30-48	The Cal. Co. 1 St.Lse. 822		Offshore Gulf of Mex. Plaquemines, La	20"@425'; 13 3/8"@2010'; 9 5/8"@7511'	D&A		WC. Deepest formation, shale.
13,975	7-22-49 1-13-49	Kerr-McGee et al,Blk 28 Oyster Lite A-1a	Kerr-McGee	Gulf of Mex. Terrebonne, La	24", 20", 13 3/8" & 9 5/8" csg. as used in original hole. 7"@11,975' 500 sx.	69 B 55 3460 cu ft 1/4"	GOR 50,145	WC. DT 190. Disc. new field. 48 perf @ 8482-90', sand. Deep seated dome. A-1 well seismic - A-1A sidetracked hole.
13,977	7-14-49 1-27-49	Shell A-3 Weeks Island		Weeks Island Iberia, La	16" 120'; 10 3/4" 4489'; 7 5/8" 13,965'	411 B 33 543 Mcf 10/64"	T 2750 GOR 1320	FW. DT 150. 60 perf @ 13,775-790', S-1 sand, 175' thick. Deepest form, shale and sandy shale. 92 bits.
14,000	9-3-49 11-10-48	Gulf D-3 St Martin Land	Co.rig 7	St Martin,La	20" 73.19' 48 1/2# Sp. 250 sx; 13 3/8" 2496' 54 1/2 & 61# SS 1000 sx; 9 5/8" 9179' 40, 43 1/2 & 47# SS 1000 sx; 7" 12,909' 26# N-80 SS 165 sx.	37 B 43.9 3440 Mcf 3/16"	T 4250 GOR 90,400	WC. DT 255. Disc. new sand. 50 15/32" perf @ 12,298-340', Frio, 68' thick. Salt dome Subsurface data. 160 cores. Bits, rock 68, drag 46. T 236 F, D -12,300', PR 5971 psi. Natural mud, to lime-starch, to lime-starch-oil emulsion.
14,013 13,611	4-9-49 12-31-47	Gulf 1 Mainka	Wierson & Cochran	Bradley,NE Grady,Okla	20" 41'; 13 3/8" 522'; 9 5/8" 6629'; 7" 13,137' 1000 sx. (API 8RT - 210 jt., 26# 73 jt. 29#.)	1068 B 46.5 1815 Mcf 16/64"	C 1200 T 2550 SC 1508 ST 2762 GOR 1700	WC. DT 420. Disc. new field. 532 perf @ 12,900-13,068', 1st & 2nd bromide sd, Tulip Creek & McLish Sd. Faulted anticline. Seismic location. 41 cores. IR 5960 psi, T 210F, D 13,245',PR 5341 psi.
14,045	9-19-49 4-27-49	Humble 1 St.Lse 1480 Lake Raccourci	Dorris Bellew	L.Raccourci Natchez,Miss	7" 13,997' 38 & 29# S-95 650 sx Trinity Inferno	120 B 56.2 5559 Mcf	C:sealed T 4500 GOR 46,325	WC. DT 54. 18 perf @ 12,135-38, miocene. Disc. new sd. Cores, 2 Con, 89 SW. Bits, rock 60, drag 13.
14,046	7-4-48 10-14-47	Stanolind 1 Henry	Glasscock	McMullen,Tex	13 3/8"@1480' 1100 sx; 9 5/8"@7520' 1000 sx.	D&A		WC. DT 248.
14,130	1-9-50 8-24-49	Lloyd 32	Drilling & Exploration	Ventura Ventura,Cal	13 3/8" 1240' 54.5# 1200 sx; 7 5/8" 12,489 33 & 39# 1500 sx; 5" 12,401-14,118' 18# 150 sx	Oil & gas		FW. DT 110. Perf 20/ft 3/16" @ 13,175-14,118', Repetto (?), 5000' ∠ (?) thick. Anticline.
14,278	12-6-49 5-3-48	Gulf 1-E Porter "A"	Big Chief Drlg Co.	Lipscomb,Tex	13 3/8" 308' 61# J-55 N-S 250 sx; 9 5/8" 3978' 40# N-80 N-S 1400 sx; 7" 15-1324' 29# N-80 N-S, 2716' 26# N-S, 4381' 23# N-S, 6055' 23# N-80 SS, 8150' 26# N-80 N-S, 11,171' 29# N-S 1016 sx.	Dry		WC-NF. DT 582. Deepest formation, Ellenburger. 155 cores. 36 DS. Rock bits, 275. Open fresh water mud system.
14,279	10-17-49 6-12-49	Hassie L.Hunt 2 J.S.Broussard		Vermilion,La		D&A		WC. Deepest formation, sand and shale.
14,319	3-29-49 12-23-48	Humble 1 St.Lse 1603	Co.rig 29	Lake Palourde St Mary, La	242 jt. 9 5/8" 500 sx Uniflo	Dry		WC. DT 87. Deepest formation, Miocene. 77 cores. Bits, rock 52, drag 14.
14,350	1-1-50 10-30-49	Shell 6 Smith-State Unit 1		Weeks Island Iberia, La	16" 120'; 10 3/4" 4502'; 7 5/8" 14,350'	428 B 34 300 Mcf 11/64"	T 2300 GOR 702	FW. DT 79. Perf @ 13,950-65', "R" sand, 60' thick. Deepest form, sand. 61 bits.
14,437	5-10-49 1-3-49	Humble 1 Humble-Fee- Weeks	Co.rig 26	Weeks Island Iberia, La	9 5/8" 12,487' 40 & 43# N-80 800 sx Trinity	Dry		FW. DT 116. Deepest formation, Miocene. 82 SW cores. Bits, rock 47, drag 4.
14,451	8-7-49 11-15-48	Kerr-McGee et al A-1 Oyster Lite Blk 28	Kerr-McGee	Gulf of Mex. Terrebonne, La	24"@169'; 20"@339' 500 sx; 13 3/8"@2267' 1000 sx; 9 5/8"@7092' 600 sx; 7"@11,859' 200 sx	Abandoned		WC. DT 293. Perf, 5 1/2" @ 11,754-5', 4 1/2" @ 11,349-50'. Hole lost and redrilled as Oyster Lite A-1a, which brought in field. 209 cores. Deepest in Gulf.
14,470	1-2-49 3-15-48	Humble B-4 J.W.Burguieres	Co.rig 26	Weeks Island Iberia, La	9 5/8" 12,701' 47,40 & 43.5# N-80, 47 & 43.5# S-95 500 sx Uniflo	Dry		FW. DT 204. Deepest formation, Miocene. Bits, rock 94, drag 5.
14,486	1-14-49 4-6-48	Superior 56-35 Anderson	Superior	Paloma Kern,Cal	7 5/8" 2987' 33 & 39# X-Line cem. 11,550 2000 sx; 5 1/2" 14,482' 20# N-80		Packer T 700	WC. Prod, 13,000', Upper Stevens. Deepest form, Lower Stevens. Anticline structure. 125 mesh perf @ 11,498-823' & 11,863-983'. 77 cores using diamond core heads. 3 DS. 146 bits.
14,564	4-22-49 7-3-48	Superior 4 LLE St. Unit 12	Superior	Four Isle Terrebonne, La	16"@138' 250 sx; 11 3/4"@2091' 47# J-55 1250 sx; 7 5/8"@13,505' 33 & 39# N-80 1225 sx.	699 B 47.7 40,121 Mcf 20/64"	T 3600 GOR 33,764	FW. DT 161. Perf. 214 - 15/32" @ 13,350-68' & 13,399-415', Shale. Piercement type dome. 84 cores.
14,650	4-15-49 10-12-48	Humble 1 St.Lse 1450	Hawkins	L.Raccourci Lafourche,La	7" 13,707' 32# S-95 270 sx. Uniflo	163.5 B 57.5 880 Mcf	T 3250 GOR 5380	WC. DT 41. Disc. new field. 24 perf @ 9834-37', Miocene. Prod. to 10,000'. Cores 3 Con, 97 SW. Bits, rock 49, drag 13
14,767	6-30-49 10-6-48	Placid & Union-Cal 1 New Orleans		B.Champagne Lafourche, La		J&A		WC. Deepest formation, shale.
14,900	3-29-49 11-24-48	Shell B-4 Smith-State		Weeks Island Iberia, La	16" 120'; 10 3/4" 4487'; 7 5/8" 13,882'; 5" 14,895'.	528 B 34 579 Mcf 11/64"	T 2650 GOR 1096	FW. DT 97. Perf @ 13,920-23', "R" sand, 100' thick. Deepest formation, shale.
14,923	10-8-49 4-27-49	Humble 1 St. Lse 1452	Delta Gulf Drlg	L.Raccourci Lafourche, La	7" 14,473' 29 & 38# S-95 & N-80 682 sx Uniflo.	179 B 48.4 4123 Mcf	T 5100 GOR 23,034	WC. DT 110. Perf. 132 @ 14,434-67. Deepest form, Miocene. Cores, 2 Con, 96 SW. Bits, rock 49, drag 13.

11

TENSLEEP SANDSTONE IN BEAVER CREEK FREMONT COUNTY, WYOMING



Mud (Aquagel) R_m = 1.3 ohms at BHT

Bit Size: 6¾"
Spacings: AM = 16"
AO = 24'

"MicroLog": Normal 1"
Normal 2"

The "MicroLog"* is made of two curves both taken with a very small spacing in which the action of the mud is practically eliminated and the electrodes directly applied against the formation.

The "MicroLog"* is especially adapted to locate accurately the permeable sections in hard formations.

Quantitatively it is the best tool to determine the "sand count." In this example, a total count of 55 feet of permeable sandstone is shown by the "MicroLog."

* "MicroLog" and "MicroLogging" are trade marks of Schlumberger Well Surveying Corporation.

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TABLE 3—CONCLUDED. DESCRIPTIONS OF WELLS DRILLED BELOW 12,000 FT IN 1949

TD, ft PB, ft	Complt'd Spudded	Company and name of well	Drilled by	Field, County, State	Casing and cementing schedule	Init. prod., grav., choke	Wellhead pressures*	Remarks
15,003	2-8-49 4-9-48	The Tex. Co. 1 St Lse 919	Hillburn Drlg Co.	Leeville Lafourche, La	13 3/8"@2600' 500 sx; 8 5/8"@12,004' 1000 sx; 5 1/2"@15,003' 400 sx.	P&A		WC. DT 181. Deepest formation, shale.
15,014	8-4-49 2-28-49	The Tex. Co. 1 Caillouet	Loffland Bros.	Leeville Lafourche, La	13 3/8"@2590' 300 sx; 9 5/8"@11,970' 1000 sx; 7"@14,082' 400 sx.	276 B 1/8"	T 2490	FW. DT 145. New sd & extd. fld. 240 perf @ 13,740-70'
15,154	5-3-49 7-28-48	Superior 3 S.Tex.Dev.Co.	Co.rig	Lake Creek Montgomery, Tex	13 3/8"@1506' 61 & 54# J-55 1200 sx; 9 5/8" @11,780' 53.50# 1500 sx; 7"@10,949' N-80.	Dry		FW. Gas injection well. Perf. 11,010-30'.
15,470	9-18-49 3-22-49	Union Prod. 2 Buckley-Mahler	Loffland Bros	Delarge Terrebonne, La	20" 149'; 13 3/8" 2969' 61# 1000 sx; 9 5/8" 11,237' 1300 sx; 7" 2924' 32# 550 sx.	792 B 27,000 Mcf 3/8"	ST 3788	FW. DT 170. Extended field. Prod. 13,378-84'. Perf. 190 @ 13,350-389', miocene. Deep seated salt dome. 5 DS.
15,543	1-3-49 6-16-48	The Tex.Co. B-2 St.Lk.Pelto	Co.Drlg. Dept.	L. Pelto Terrebonne, La	17 1/2"@2528' 500 sx; 8 5/8"@12,003' 1000 sx.	Dry		WC. DT 192. Plugged and abandoned.
15,659	2-7-49 6-26-48	Humble 2 J.R.Williams	Dorris Ballew	W. Chatom Wash., Ala	9 5/8" 8929' 42# N-80 840 sx. LS Portland	Dry		WC. DT 216. Deepest formation, Eagle Mills. 94 Con, 33 SW cores. 1 DS. Rock bits 186. Deepest in Alabama.
15,866	9-8-49 2-28-49	Standard-Cal. 5, Mushrush	Standard-Cal.	Wasco Kern, Cal.	13 3/8" 1030'; 9 5/8" 8100'; 6 5/8" 13,053'; 4 1/2" 15,863'; plug 15,535'.	352 B 40.4 1218 cu ft	ST 1000 GOR 3460	WC (deep). World's deepest prod. DT 95. Perf. 4 1/2"/ft @ 15,440-530', Eocene. Anticline structure. Drilled water base; liner run in emulsion base.
15,913	9-27-49 3-31-49	Shell 1 Weeks-Call St. Unit 1		Weeks Island Iberia, La	16" 120'; 6 3/4" 4502'; 7 5/8" 14,500'; 5" 15,913'.	574 B 34 651 Mcf 11/64"	T 2250 GOR 1134	FW. DT 152. Perf. 90 @ 14,150-65', "R" sand, 52' thick. Deepest form, shale. 120 bits.
16,347	1-29-49 8-5-47	Humble 1 R.P.McWatters	Co.rig 32	Freestone, Tex	5 1/2" 11,784' 23 & 20# N-80 325 sx Slo Set.	6500 Mcf 53.6 1/4"	SC 950 ST 1775 GOR 62,900	WC. Disc. new gas-cond. field. DT, 410. Perf. 680 @ 8315-8400', Pettit. Deepest form, Massive Limestone. Cores, 63 WL, 69 SW. DS 10 w/top & btm. Shut in. Bits, rock 237, drag 14.
18,734	3-13-49 9-6-48	Superior 1 Limoneira		SBPM Ventura, Cal	9 5/8"@11,209' 47 & 53.5# N-80 R-3 5 Rd. Thd. N-S extreme line.			WC. DT 189. Deepest form, miocene. Faulted anticline. 20 cores. Rock bits 172.
20,521	6-18-49 7- -47	Superior 1 Pacific Creek	Dyer & Rice to 9881'	Sublette, Wyo	13 5/8" 10621'; 9 5/8" 9929' 1500 sx; 8 3/8" 16,171'; 7" 19,765' 1000 sx.	None		WC. World's deepest well. Bits, rock 191, diamond 10.

Flowing pressures: C-casing, T-tubing. Shutin pressures: SC-casing, ST-tubing. GOR-gas oil ratio. WC-wildcat. FW-field well. IR-initial reservoir pressure. PR-present reservoir pressure. D-datum. DT-drilling time. DS-drillstem test. Producer flowing unless otherwise stated.

(Text Continued From Page B-8)

its deepest production at 12,340 ft when Gulf Oil No. D-3 St. Martin Land well went to 14,000 TD. Initial production was 37 bbl oil and 3,440,000 cu ft gas.

The third new deep sand discovery in Louisiana was made by The Texas Company No. 1 Caillouet, Leeville field, Lafourche Parish, which drilled to a total depth of 15,014 ft and found a new sand at 13,740-70 ft. Initial production was 276 bbl oil a day.

Hunt Oil Company found a new deep sand in the Duck Lake field, St. Martin Parish, Louisiana. The gas-producing formation is about 60 ft thick. Total depth was 13,594 ft.

Most of the discoveries indicate excellent possibilities of developing good productive reservoirs.

Bits

On deep wells an average of 118 drilling bits were used for each well in 1949. This is up from the 96 bits used in 1948 and accounts for some of the higher cost.

As usual the Lousiana Gulf Coast required the smallest number, averaging about 32 bits per well but all Louisiana deep wells needed an average 58 bits per well. At the other end, New Mexico wells used an average of 209 bits per well; California wells used 197 bits; Oklahoma wells, 195; Wyoming, 181, and Texas, 154 bits per well.

Texas also showed a wide difference in number of bits used in the Gulf area and the northwest portion of the state. Deep wells around the Gulf required an average of 73 bits and all other Texas deep wells used 201 bits per well.

Drilling Time

One of the most optimistic aspects of deep drilling and the possibility of lowering costs in comparison with shallow wells is the impressive drop in drilling time. Here is the average drilling time per deep well in the United States for the last three years:

149 days per well in 1949
162 days per well in 1948
180 days per well in 1947

This means drilling time only and does not necessarily mean all the days between rigging up and completion.

There were only four deep drilling operations last year that showed more than 400 days drilling time and during the same period six wells were drilled below 12,000 ft in less than 50 days, all of them in Louisiana. Humble had two real records: A field well in Pecan Island field, Louisiana, was drilled to 12,450 ft in 22 days and a wildcat in Iberia Parish went to 13,693 in 27 days drilling time.

As formerly, a relatively few deep wells increase the average drilling time but the trend is for these to grow fewer. In West Texas, Oklahoma, and Wyoming, deep drilling consumes more time because of hard formations that require more frequent change of bits. Greater length of time is required also for the more thorough testing that is usually a part of deep operations.

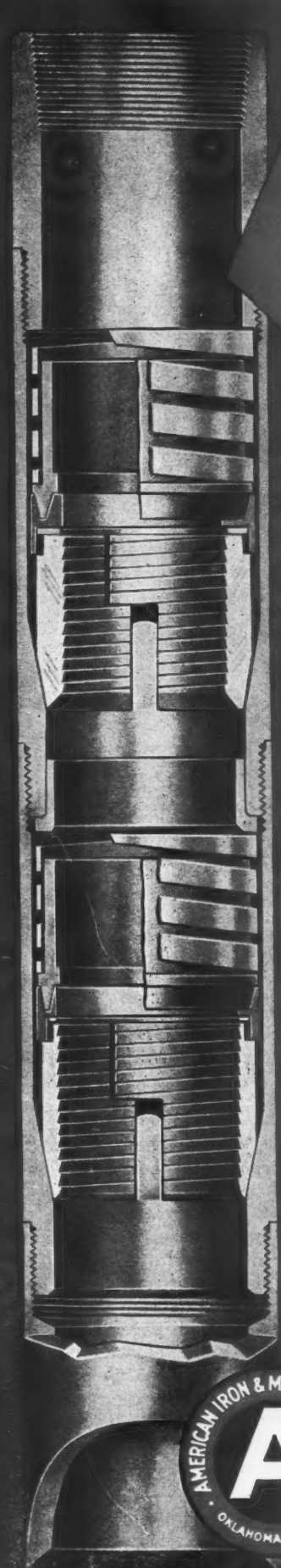
Testing Formations

Although statistics are pretty light so far as coring and drillstem testing goes in early deep drilling operations, it is apparent that a great deal more testing is done presently. Most of those who had available records of the number of cores taken and drillstem tests made indicated substantial testing. It is not unusual to take approximately a hundred cores from one well including diamond, sidewall, and wire line.

It should be remembered that a large proportion of the deep wells are wildcats and operators are drilling for information as well as for oil and gas. The data on deep structures is accumulating more rapidly as deep drilling accelerates. This fund of information will lead eventually to more oil and gas finds in deep pools.

Conclusion

There is no question that increased deep drilling has brought greater proportionate returns in new reservoirs. Results of this sixth annual survey of deep wells will be discussed further in a coming issue. An attempt will be made to show the influence of various factors on costs and to link the deep fields with geological maps. ***



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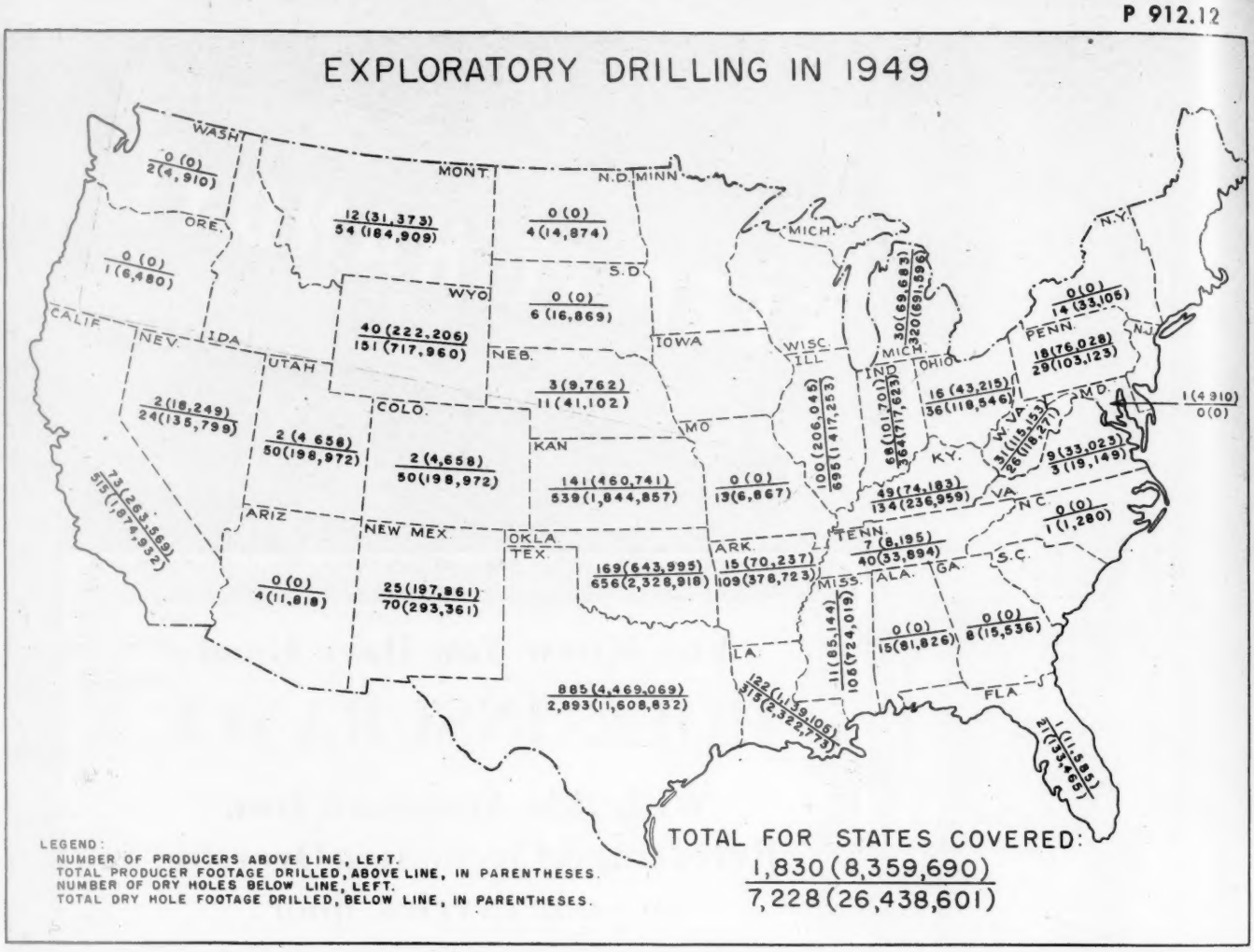

FIG. 1.

Exploratory Drilling in 1949[1]

FREDERIC H. LAHEE[2]

OUR committee has continued to use the classification of exploratory holes as outlined in Table 1, and the same classification is used in Canada and Mexico. All holes are grouped according to their preliminary classification (I in Table 1), whether their original objective was attained, or not. Under this classification (I), the holes are then grouped according to their completion classification (II in Table 1). It is to be noted that, while a majority of outposts, or, as we may also call them, "extension tests," if successful, are completed as extension wells, some discover new pools and therefore are completed as new-pool discovery wells. Similarly, any type of new-pool test, if successful, may sometimes be completed as an extension well rather than as a new-pool discovery well. These possibilities are indicated in parentheses under Col. B, 2a, 2b, and 2c, in Table 1.

Definitions of the several types of exploratory hole are given on pages 631 to 634 of the summary for 1944.[3] Except where otherwise designated, the statistics recorded in the present report are similar to those used in our reports from 1939 to 1948, inclusive. All holes drilled below ground may be grouped (1) those drilled for oil or gas, or (2) those drilled for other purposes. All holes drilled for oil or gas may be classed as (1) those that are *field-development wells*, located within or close to the developed part of an oil pool or gas pool (within the area of proved reserves), and drilled further to develop the pool or pools already partly developed; or (2) those which are *exploratory* in the sense that they are searching for new and as yet undiscovered pools or are searching for *long* extensions of pools already partly developed. We are here concerned only with the exploratory holes.

All exploratory holes are drilled either (1) on structures not yet producing, or (2) on structures already producing. Holes of the first of these

1A summary of the paper to be presented before the American Association of Petroleum Geologists at Chicago, April 24, 1950, and to be published in full in the June, 1950, issue of the Association Bulletin.

2Geological and research counselor, Sun Oil Company, Dallas, Texas; chairman AAPG committee on exploratory drilling statistics.

3See references.

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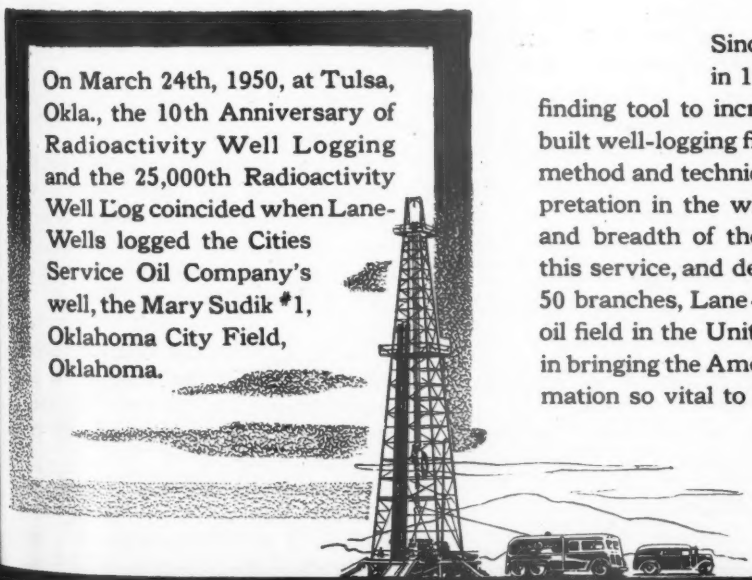

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SUMMARY

The fifth annual report on data gathered by the AAPG committee on statistics of exploratory drilling shows that:

During 1949, 9058 exploratory holes were drilled in the United States. Of these 4449 were new field wildcats, 2457 were new pool tests (including new pool wildcats, deeper pool tests, and shallower pool tests), and 2152 were outposts. Among the new field wildcats, 506 were successful; among the new pool tests, 656 were successful; and among the outposts, 668 were successful.

The total exploratory footage drilled in the United States in 1949 was 34,798,291 ft in the 9058 holes, or 3842 ft per hole. These figures compare with 32,741,097 ft drilled in 8013 exploratory holes, with an average depth of 4086 ft in 1948. For the second time the committee is presenting data on Canada and Mexico.

two classes are *new field wildcats*. Occasionally, where structures are ill defined and porosity varies considerably within relatively short distances, exploratory holes may be grouped as new field wildcats if they are 2 miles or more distant from the nearest production. Holes of the second class (on structures already producing) may be (1) *outside* the developed area (area of proved reserves),[4] in which case they will be either (a) outposts or (b) new pool wildcats according to whether they are drilled (a) to extend a partly developed pool (reservoir) or (b) to explore for a new pool; or (2) *within* the proved developed area of the pool, in which case they may be deeper pool tests (exploring *beneath* the deepest pool penetrated by the hole) or shallower pool tests (exploring for a new pool *above* the deepest developed pool at the site of the well in question). There are very few exploratory holes that belong to this last class, i.e., shallower pool tests. Most of the wells of this kind are field-development wells that happen to find new shallower pools. In other words, such holes were not drilled for the purpose of *exploring* for a shallower reservoir. Only rarely is such exploration undertaken, and then usually where suggestions of lensing or faulting indicate that there may be a chance for a shallower accumulation.

On the maps (Figs. 1 and 2), numbers in parentheses indicate total footage drilled; figures preceding parentheses indicate the number of holes drilled; figures above the cross line are for producing wells, that is, oil, oil and gas, condensate (distillate) and gas, or gas; and figures below the cross line are for dry holes.

In the states covered in this review, as shown in Fig. 1, during 1949 a total of 34,798,291 ft was drilled in 9058 exploratory holes, divided as follows:

1830 producers .... 8,359,690 ft.
7228 dry holes .....26,438,601 ft.

This means that 20.2 per cent of the holes drilled, and 24.0 per cent of the footage drilled, were successful in 1949. One producer foot was drilled for every 3.16 ft of dry hole. One successful well was drilled for every 3.95 dry holes. The average depth of hole was 3842 ft.

According to figures compiled, 464 new field wildcats drilled on technical advice (geology and/or geophysics) were successful, and 3143 were dry; 11 holes, located for non-technical reasons, were producers, and 367 were dry; 30 producers and 433 dry holes were located for reasons unknown. These figures show that 12.9 per cent of the holes drilled on technical advice were producers as contrasted to 3.0 per cent successful in the case of the holes located without technical advice. Therefore, in 1949, locations for new field wildcats based on technical recommendations were 4.3 times as successful as those drilled without such advice. Seismographic methods were primarily responsible for 248 producers and 896 dry holes, among the new field wildcats.

TABLE 2. Relative Success of exploratory drilling in U. S. from 1944 to 1949, inclusive.

Year	New field wildcats: Number of dry holes for each producer	New field wildcats: Percentage of wells successful	All exploratory holes: Number of dry holes for each producer	All exploratory holes: Percentage of wells successful
1944....	8.05	11.05	4.08	19.67
1945....	7.63	11.59	3.62	21.64
1946....	8.39	10.65	4.06	19.76
1947....	7.80	11.32	3.90	20.34
1948....	7.57	11.66	4.50	18.25
1949....	7.79	11.37	3.95	20.20
Average for the six years...	7.85	11.29	4.02	19.90

In 1949, the percentage of new field wildcatting, in the entire exploratory drilling program, was very near 49 per cent. That for new pool testing was just over 27 per cent, and that for outpost drilling was just under 24 per cent.

Table 2 shows the relative success, as measured by the number of producers in comparison with the number of dry holes, in each year from 1944 to 1949, inclusive.[5]

As indicated in Table 1, a hole may be located as an outpost with the intention of trying to extend a pool partly developed, but instead it may discover a new pool; and, similarly, a new pool wildcat may be located in search of a new pool, because it is believed to be well outside the limits of the known pool, but instead it may result in extending this known pool farther than had been expected. A majority of outposts, if successful, are completed as extension wells and a

TABLE 1. Classification of exploratory wells.

			I. *Classification When Drilling Is Started* — A	II. *Classification After Completion or Abandonment* — *Successful* B	*Unsuccessful* C
Drilling for long extension of partly developed pool			1 Outpost (Extension test)	1 Extension well (Sometimes a new-pool discovery well)	1 Dry outpost (Dry extension test)
Drilling for a *new pool* on a structure or in a geological environment already productive	New-pool tests	Drilling within limits of proved area of pool — For new pool *above* deepest pool	2a Shallower-pool test	New-pool discovery wells (Or sometimes extension wells): 2a Shallower-pool discovery well (Sometimes shallower-pool extension well)	Dry new-pool tests: 2a Dry shallower-pool test
		Drilling within limits of proved area of pool — For new pool *below* deepest pool	2b Deeper-pool test	2b Deeper-pool discovery well (Sometimes deeper-pool extension)	2b Dry deeper-pool test
		Drilling outside limits of proved area of pool	2c New-pool wildcat	2c New pool discovery wildcat (Sometimes an extension well)	2c Dry new-pool wildcat
Drilling for a *new field* (on a structure or in an environment never before productive)			3 New-field wildcat	3 New-field discovery wildcat	3 Dry new-field wildcat

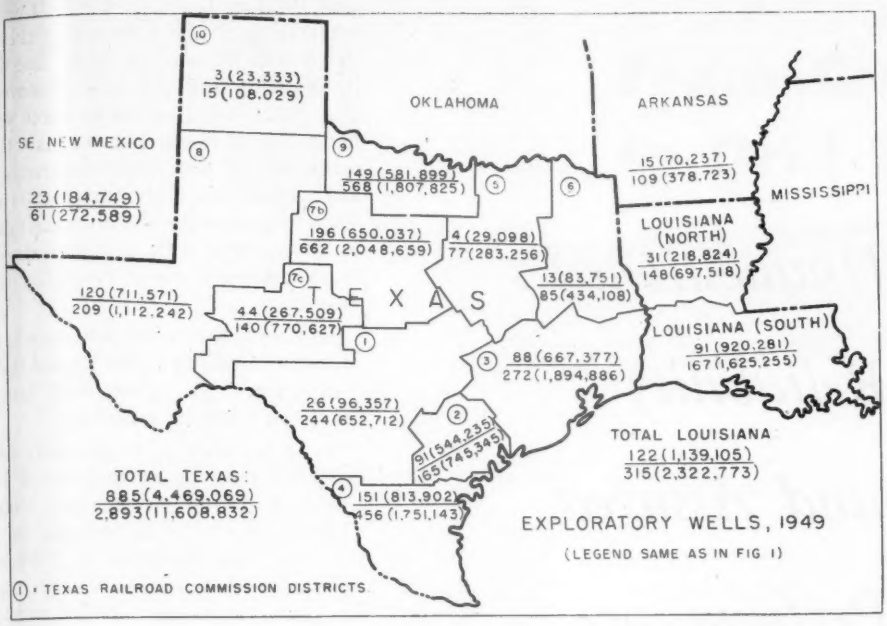

FIG. 2.

majority of new pool wildcats, if successful, discover new pools. During 1949 425 outposts were completed as extension wells and 88 were completed as new pool discoveries; and 314 new pool wildcats discovered new pools whereas 61 new pool wildcats were completed as extension wells.[6]

A question sometimes asked concerns the approximate percentage of true wildcatting (new field wildcatting) by major companies, on the one hand, and by minor companies and independents, on the other hand. Distinction between these three classes of operator is not always easy, and in some instances the same company may be regarded as a "major" in one district, but as a "minor" in another district. Consequently, we left the classification to the judgment of the various committeemen, each for his own district. Usually a major company is defined as one which is integrated with respect to at least three of the four main branches of production, transportation, refining, and marketing.

Our statistics showed that in the country as a whole in 1949, 845 new field wildcats (172 producers and 673 dry holes) were drilled by majors; 3329 new field wildcats (306 producers and 3023 dry holes) were drilled by minors and independents; and 275 new field wildcats (28 producers and 247 dry holes) were drilled by minors or independents with the drilling financed by major companies.

In recent years we have included in our annual report a table showing the number of fields discovered each year, from 1938 to the year preceding the year reported, these fields being grouped according to a rough estimate of their total ultimate reserves from the date of discovery. The fields were grouped according to these estimates: "A" meaning a total ultimate of 50 million bbl or more; "B", from 25 to 50 million bbl; "C", from 10 to 25 million bbl; "D", from one to 10 million bbl; "E", less than one million bbl; and "F", abandoned. Gas fields were not included unless they also produced condensate. A few fields were omitted where satisfactory estimates were not readily obtainable.

Each year, since we have presented this table, all the fields have been reestimated. This we have found to be a very onerous task, and not too closely related to the functions of our committee. Yet we have felt that something of the kind is desirable. Therefore, in the present report, we are changing our approach. We are recording estimated total ultimate reserves only for the discoveries of 1943, 1946, and 1949. This is the first year in which we have attempted such an estimate of the fields discovered in the year just closed. Previously we have allowed a year to elapse. The estimates were all made in January, 1950, those referring to discoveries of 1943 and 1946 being revisions, where revisions seemed necessary. In making these revisions, among the discoveries of 1946, 2 B's were raised to A; two D's were raised to C; 13 E's were raised to D; 5 D's were lowered to E, and seven E's were lowered to F. Among the discoveries of 1943, 3 B's were raised to A; 7 D's were raised to C; 17 E's were raised to D; 3 D's were lowered to E; and 15 E's were lowered to F. These changes were made in the estimates prepared for these discoveries of 1946

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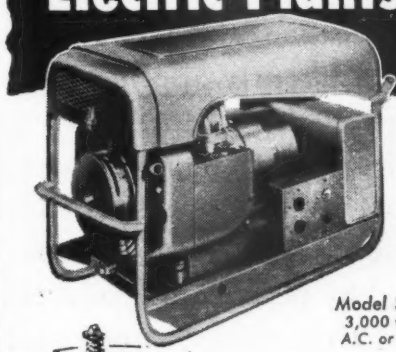

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and 1943 in January, 1949. It will be interesting to see how many changes there will be, and in what direction, in re-estimating the 1946 discoveries and the 1949 discoveries three years hence; for it is our plan to make these estimates of the fields discovered in any given year only three years and six years, respectively, after their dates of discovery, with a rough preliminary estimate given just after their discovery.

In conclusion with reference to exploratory drilling in the United States, comparing 1949 figures with those of 1948, we note the following:

1. In number of exploratory holes drilled there was an increase of 13.0 per cent, and in exploratory footage drilled there was an increase of 6.3 per cent. The increases in 1949 over 1947, based on 1947 figures, were 33.7 per cent in holes drilled and 31.8 per cent in footage.

2. Considering only the new field wildcats, 1949 witnessed an increase of 3.56 per cent in holes drilled and a decrease of 3.1 per cent in footage drilled, compared with 1948. Compared with 1947, the corresponding figures in 1949, both increases, were 27.8 and 24.2 per cent respectively.

3. In California, Illinois, Indiana Texas, and Wyoming, there were larg increases in exploratory drilling i 1949, contrasted with 1948, but ther was a decrease in Kentucky, New Mexico, New York, Ohio, Pennsylvania, and Tennessee.

4. The average depth of hole for all exploratory drilling decreased from 4086 ft in 1948 to 3842 ft in 1949. Again, this year, Louisiana holds the record (7922 ft) for average depth of exploratory hole, and Mississippi is again second with 6975 ft.

Exploratory Drilling in Canada

Statistics for western Canada were compiled by Floyd K. Beach (Alberta), J. D. Allan (Manitoba) and G. E. Cunningham (Saskatchewan). For eastern Canada, they were compiled by W. A. Roliff. This is the second annual report on Canada.

In western Canada, in 1949, 262 exploratory holes were completed, 58 of these being producers and 204 being dry holes. The producers included 37 oil wells, 19 gas wells, and 2 condensate wells. A total of 1,130,563 ft was drilled, 243,343 ft in producers and 887,220 ft in dry holes. This means that 21.37 per cent of the exploratory holes and 21.52 per cent of the exploratory footage were successful. There were 3.6 ft drilled in dry holes for every foot drilled in producers. For every producer completed, 3.5 dry holes were abandoned. The average

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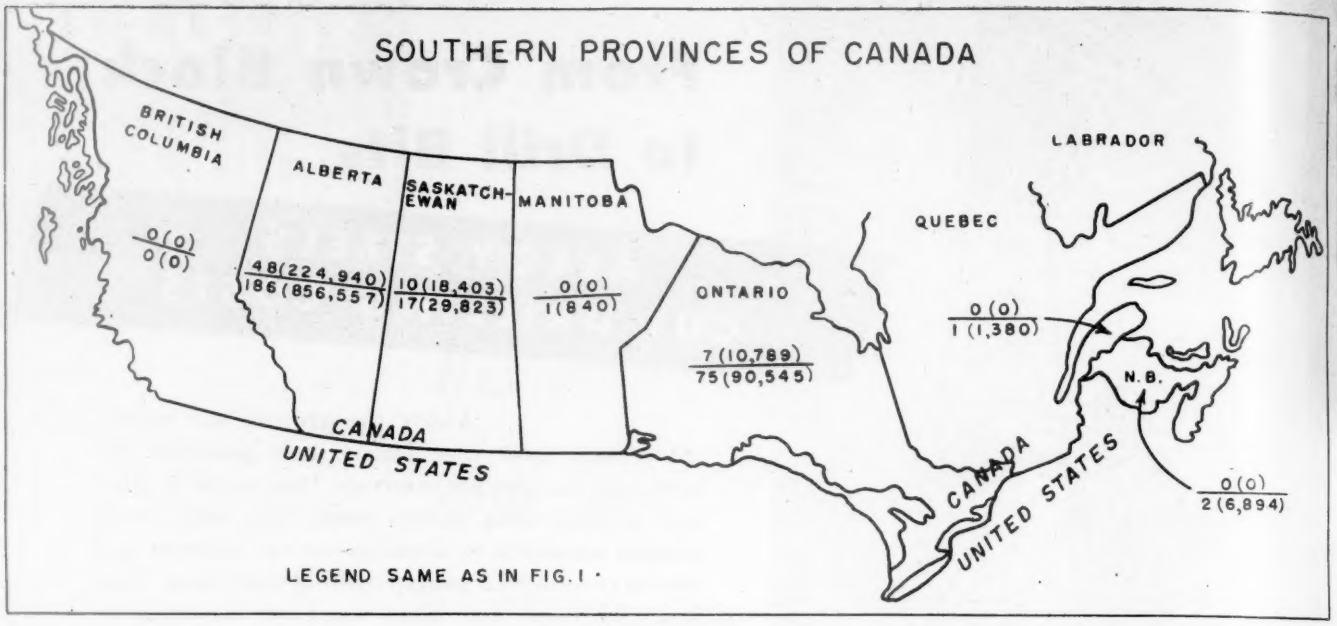

FIG. 3.

depth of all the exploratory holes was 4315 ft.

Among the 215 new field wildcats completed in 1949, 36 were successful and 179 were dry. In other words, new field wildcatting was 16.7 per cent successful. One producer was drilled for every 5 dry holes. One hundred twenty-one of the new field wildcats (20 producers and 101 dry holes) were drilled by independents. The bases for location of the 215 new field wildcats are shown in Table 3.

In eastern Canada, 85 exploratory holes were drilled, with a total of 109,608 ft. Seven of the 85 holes were successful, all as gas wells, and all in southwestern Ontario. In these producers, 10,789 ft were drilled. Of the 85 holes, 8.2 per cent were successful; 9.8 per cent of the exploratory footage was in successful holes. For every foot drilled in producers, 10.16 ft were drilled in dry holes. The average depth of hole was 1289.5 ft.

All but 12 of these exploratory holes in eastern Canada were new field wildcats. There were no successful new field wildcats. Among the 73 new field wildcats 44 were drilled by major companies and 29 by minors or independents. With reference to the basis of location, 39 new field wildcats were located on subsurface geology, 2 on surface geology, and 32 for reasons unknown.

Exploratory Drilling in Mexico

All exploratory drilling in Mexico was accomplished through the governmental organization, Petroleos Mexicanos. Data on the 1949 exploratory program were kindly provided for this report by Ing. Manuel Rodriguez Aguilar. A total of 51 exploratory holes were drilled, with a total of 272,963 ft. Of these holes, 14 (7 oil wells and 7 condensate producers) were successful, these 14 holes having a total of 77,004 ft. According to these figures, this exploratory program was 27.5 per cent successful. For each producer foot, 2.5 ft were drilled in dry holes. The average depth of all 51 holes was 5352 ft.

Twenty-three of the 51 holes were new field wildcats, and 3 of these, or 13 per cent were successful. All were drilled on a technical basis as follows:

1 producer and 4 dry holes were located on geology.
1 producer and 9 dry holes were located on geophysics.
1 producer and 7 dry holes were located on both geology and geophysics.

General Conclusion

Probably the most striking thing brought out by our analysis of the 1949 exploratory drilling in the United States is the big gain over 1948. In 1948, 8013 exploratory holes were drilled, and in 1949, 9058 such holes were drilled. If this campaign should continue to expand through 1950, we may have a total for this year of more than 10,000 such holes. However, it remains to be seen whether threats against depletion allowance will have a dampening effect on the industry's efforts to find new oil. In this connection, the record demonstrates clearly that, on the average, during the last 6 years, for every producing new field (rank) wildcat, 7.85 additional dry holes had to be drilled. For every foot drilled in "successful" new field wildcats, 6.12 ft were drilled in dry new field wildcats. In other words, for the 12,697,431 ft drilled in 2428 successful wildcats in the 6 years from 1944 to 1949, inclusive, the industry drilled 77,741,298 ft in 19,061 *dry* new field wildcats. And let no one forget that relatively few of the so-called "successful" wildcats discovered *major* fields. Many were on the border line between economic success and failure. These are significant facts which should be considered by those who, directly or indirectly, would stifle the industry's ambition for exploration.

TABLE 3. Basis for location of western Canadian new field wildcats.

	Geology	Geophysics	Geology and geophysics	Total technical	Non-technical	Unknown	Total
Producers...	4	21	6	31	3	2	36
Dry holes...	45	82	20	147	25	7	179
Total.....	49	103	26	178	28	9	215

References

3. "Exploratory Drilling in 1944," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 29, No. 6 (June, 1945), pp. 620-45.
4. By "area or proved reserves" we mean the area which may definitely be said to have been proved for future production by the wells already drilled in the pool. This area includes the drilled producing units, those *inside* units which it is believed will surely produce when drilled, and in pools on reasonably simple structure, those *outside* units which adjoin the drilled producing units and which, likewise, it is believed will produce when drilled.
5. The same data for *all* exploratory holes are graphically shown from 1938 to 1949 in the article, "Exploratory Drilling in the United States During the Last 11 Years," Frederic H. Lahee, *The Petroleum Engineer*, July, 1949.
6. The new pool discoveries referred to in this paper are all the result of exploratory drilling. In addition to these, at least 105 new pools were discovered in the drilling of field-development wells. These included 89 discoveries of oil, 11 of gas, and 5 of condensate.

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Basically, the Baash-Ross Signal Warning Control consists of a Limit Switch Assembly that is installed in the crown, and a Control Box and Horn unit that is installed near the driller's position at the rig floor. It is operated by simply connecting to the rig air supply and lighting circuit.

The Limit Switch is attached to the water table in the Crown, and the Weight Assembly suspended from the Limit Switch is placed around the deadline a little above the upper operating limit of the blocks. This Weight Assembly is split and hinged for easy installation on the dead line, and is equipped with hard rubber rollers to permit free movement up and down the line without wear or friction. Also note in the illustration that the suspension cable between the Switch and Weight Assembly incorporates a shock absorber spring to prevent damage to the Limit Switch unit.

As long as the blocks remain below the danger zone in the crown, the Weight Assembly suspended from the Limit Switch holds an electrical circuit closed. However, the instant the blocks move into the danger zone they lift the Weight Assembly, causing the Limit Switch to open and the Air Warning Horn near the driller's position to sound.

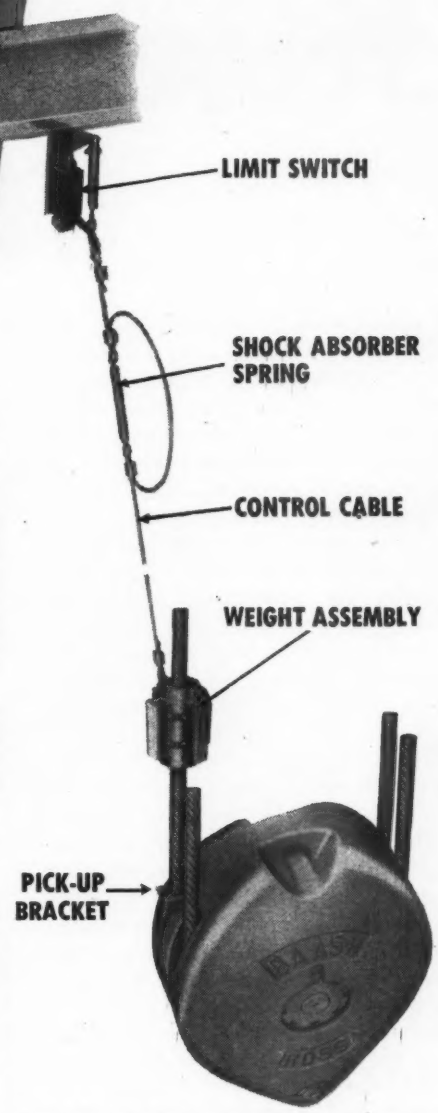
It is important to note that the Baash-Ross Warning Control is so arranged that the electric current flows through the circuit to *prevent* the warning horn from blowing—not to *cause* it to blow. This is a vital safety feature, for should the current be interrupted for any reason at all—either by lifting the Weight Assembly or by failure in the power supply, short circuits in the rig wiring, etc.—the warning horn will immediately start blowing. If the blocks are not in the danger zone then the crew knows immediately that the power supply should be checked. But as long as the air horn remains silent the Warning Control is in proper operating condition—*a valuable self-checking protective feature!*

Another valuable feature is that a by-pass switch is provided in the Control Box to permit operating the blocks in the danger zone when necessary by pressing this switch in by hand. However, as soon as pressure is released, the switch *automatically* returns to its normal open position, preventing risk of someone forgetting to re-set the switch after use.

Automatic Control Equipment

The Baash-Ross Signal Warning Control can also be provided with accessory equipment to automatically disengage clutches, apply brakes and shut-off power to the draw works (depending upon the type of draw works and power unit used) whenever the blocks are raised into the danger zone. This accessory equipment can be readily varied to meet the operator's particular requirements—and also to meet the varying requirements of steam, electric and diesel-powered rigs.

The Baash-Ross Signal Warning Control is low in price, yet provides vital protection every drilling rig should have. After its simple installation it becomes a permanent part of the rig and is an investment that pays dividends over many years of trouble-free operation. *Write today for full details on this important safety development—or see your nearby Baash-Ross representative.*



View showing how Limit Switch Assembly is attached to water table in crown and supports Weight Assembly placed around dead line. When traveling block raises Weight Assembly, the Limit Switch is released to sound alarm and, if so equipped, to actuate automatic shut-off equipment on hoist.

Control Box and Warning Horn are placed at any convenient point near driller. Control Box is connected to Limit Switch Assembly through conduit for derrick lights.

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Evaluating Native Clays For Use as Drilling Muds

A method of tabulating native mud characteristics and classifying them according to a "merit" index.

V. B. ZACHER*

A GREAT deal of time and effort has been spent in recent years testing various clays for use as rotary mud. In many of these tests on unknown clays, the results are sufficiently decisive to simplify classification. There are many others, however, that may be termed "borderline" samples, possessing some good and some bad qualities, that are much more difficult to classify. The procedures and forms used for reporting the results of tests on native clays are as numerous as the companies involved, as each one employs a form best suited to its own needs.

Up to several years ago, the company with which I am affiliated had in effect a system of recording the important characteristics merely in tabular form. It was noted, however, that when it became necessary to evaluate the sample on the basis of the tabulation, there were just too many variables to permit an accurate estimate. For example, when heavy weight material was discovered, the question arose as to how high a fluid loss it would take to nullify the weight advantage. The good and bad qualities seemed to cancel each other out, and it was difficult to arrive at any satisfactory conclusion.

The situation was further complicated by the fact that we had no method then of measuring the effects of dissolved chemical impurities, such as calcium, magnesium, sulphates, chlorides, etc. We know now, of course, that the tests for these ions are very important in supplementing physical tests, as they not only confirm the physical tests but often help to explain otherwise unaccountable variations or deviations in physical behavior.

It became obvious, too, that there must be different measuring sticks for the evaluation of colloidal clays or gels and average or heavy weight drilling muds. These are entirely dissimilar in character, and actually are used for entirely different purposes, so that a single system for testing both didn't seem at all feasible. The result was that we finally developed two separate formulae, one to apply to each type of clay.

The method of evaluation adopted is somewhat analagous to that employed by R. L. Rolf, consulting metallurgist, who published an article in the July, 1934, issue of *Heat Treating and Forging*. Rolf had worked out for his purposes a formula that combines the four cardinal physical properties of steel, namely, ultimate strength, yield point, per cent elongation, and per cent reduction of area. Ordinarily, in any metal, if the per cent elongation and reduction of area are great, it is ductile, hence, the yield point and tensile strength are low, as, for instance, in lead. In other words, ductility, the property of toughness, is usually obtained at the expense of tensile strength. Rolf pointed out in his article that any steel is a good product if it has a combination of high ductility and high tensile

FIG. 1

Tide Water Associated Oil Co.
Technical and Research Dept.
Ventura, Calif.

STANDARD TEST OF AVERAGE OR HEAVY MUDS

How and where sampled_____ Name of clay_____

Supplier_____

Date Sample Received_____ Date Tested_____

DATA FOR MUD INDEX — REMARKS

_____ WEIGHT (lbs./cu. ft.) @ 30 secs. visc. "W"

_____ WATER LOSS (cc) "L"
_____ FILTER CAKE (mm) "T" } @ 78#/cu. ft. & 185° F. (wt. a constant)

_____ REACTION TO CHEMICAL (TSPP) from 30 secs. visc. @ 1#/bbl. "R"

_____ INDEX $\frac{(\quad)\text{ "W" x } 1000}{(\quad)\text{ "L" x }(\quad)\text{ "T" x }(\quad)\text{ "R"}}$

Where: "W"=Mud Weight (#/cu.ft.) @ 30 secs. visc.
"L"=Water Loss (cc) } @ 78#/cu.ft. & 185° F.
"T"=Filter Cake (mm) }
"R"=Reaction to TSPP (from 30 secs. visc. @ 1#/bbl. or 1.7 grams/600 cc)

DATA FOR USE AS STRAIGHT DRILLING MUD

_____ Salt Content (grains/gallon using above filtrate)

_____ Sand Content (% by weight based upon dry solids)

_____ Water Loss (cc)
_____ Filter Cake (mm) } @ 78#/cu.ft. & room temp.

ION CONCENTRATION (lbs. per bbl.)

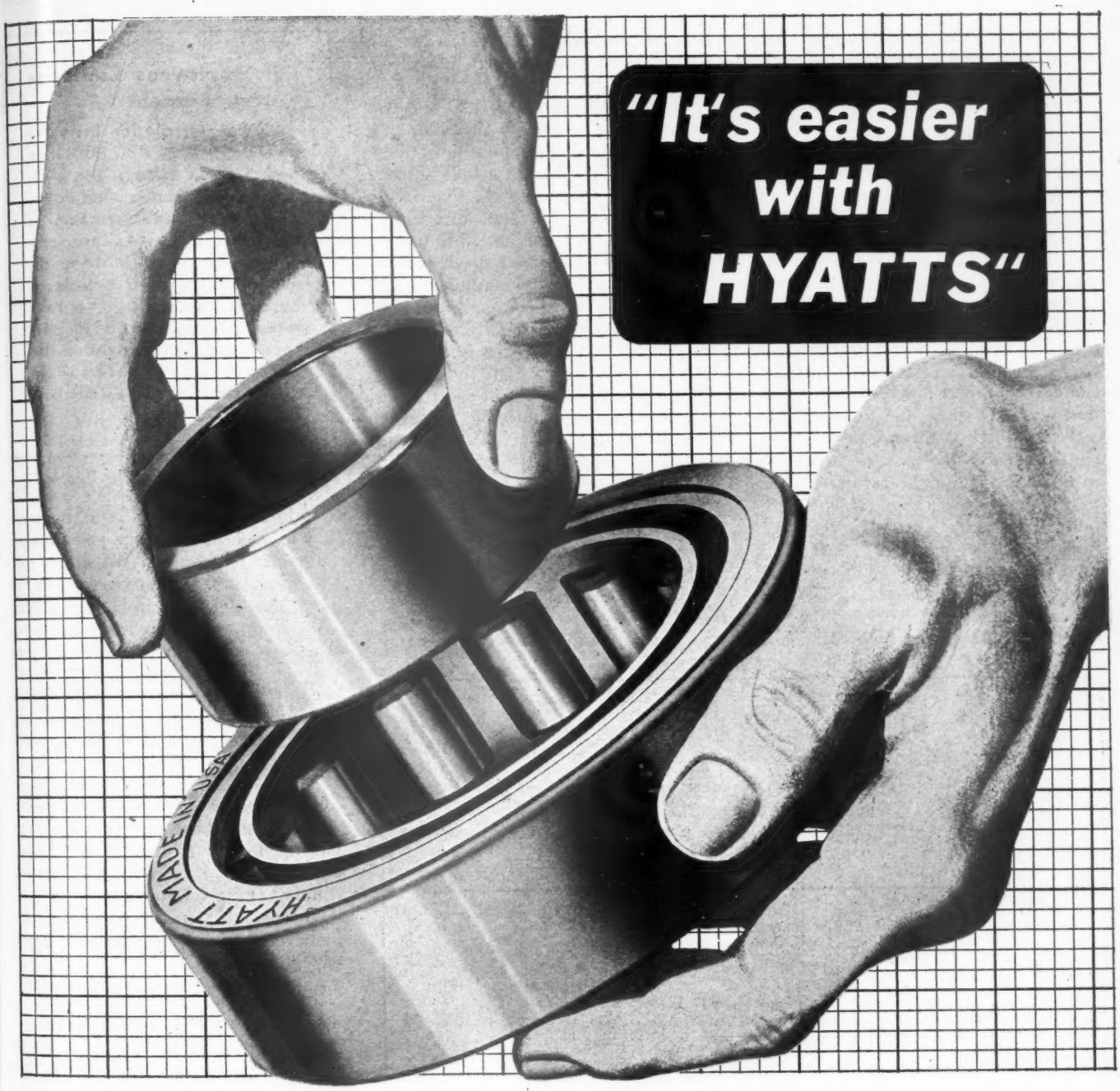
Ion	Conc.	Ion	Conc.	Ion	Conc.
Nitrate (NO_3)		Calcium (Ca)		Manganese (Mn)	
Nitrite (NO_2)		Carbonate (CO_3)		Sulfate (SO_4)	
Ammonia (NH_3)		Magnesium (Mg)		Chloride (Cl)	
Phosphate (PO_4)		Aluminum (Al)		Sodium (Na)	
Potassium (K)		Iron (Fe)		pH	

Note: All viscosities @ 500 cc in and 500 cc out, through 3/16" orifice. All filter tests taken at 100#/sq. in. from zero to 15 min. using 3" dia cell. TSPP abbreviates Tetra Sodium Pyro Phosphate, anhydrous.

Signed_____

*Tide Water Associated Oil Company.

EXCLUSIVE



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strength. His formula thus develops one number that is proportional to the merit of the steel.

In considering clay for drilling mud, we can say, similarly, that if a mud used for ordinary drilling has high weight yet a low water loss, it is —barring certain impurities—a good product. Although, by looking at these characteristics separately, we can not tell which mud is best for our purposes, we have combined our most important tests into a relationship, or formula, that means that the value of a drilling mud is directly proportional to its weight and, inversely proportional to its water loss, cake thickness, and viscosity drop due to chemicals.

With a light or colloidal mud we can say that value may be expressed in the same relationships, except that in this instance, weight is unimportant. In its place we use *yield*, expressed as the number of barrels of mud per ton of dry clay. This *yield* value has the advantage of reflecting the colloidal condition of the mud, because, in general, the higher the dispersion, the higher the yield in barrels of mud per ton of dry clay at a given viscosity.

In evaluating most muds by this expression, the result is a decimal, and the numerator is, therefore, multiplied by 1000 to produce a whole figure, which we have termed the "merit index." The water loss tests are, in the case of the heavy mud, at 78 lb per cu ft, and 185 F. This, we believe, is fair, because we are merely adjusting the weight of solids in competitive muds to a definite and comparable value. Of course, this treatment penalizes a lot of muds whose weight goes up because of a high content of inert material. That seems permissible, however, because we are trying to get a mud that is not only light in weight (with a certain proportion of inert material) but also one that has the proper particle size distribution and colloidal properties to give us a low water loss.

Similarly, in the light or colloidal muds, we must use some other constant besides weight, with water loss, to compare competitive muds, because these colloidal muds have variable weight characteristics, and it seems best to make constant the gel structure character of the mud. We simply use, therefore, a 30 second viscosity as the point at which yield in barrels of mud per ton and all water losses are read. This viscosity is low enough so that thixotrophy does not interfere with the flow and filter characteristics. This is also at standard temperature, 185 F, as heat imposes an effect on water loss.

The factors to substitute into these expressions can be determined easily in any field laboratory, provided it is equipped with a proper mud mixer and hot plate, in addition to other ordinary testing instruments.

Below are the two formulae, together with a description of the terms used:

Merit index

Average or heavy muds	Light or colloidal muds
$\text{Index} = \frac{1000\ W}{L\ T\ R}$	$\text{Index} = \frac{1000\ Y}{L\ T\ R}$
Where: W = Mud wt., lb/ft³ @ 30 secs visc	Where: Y = Yield, bbl/ton @ 30 secs visc = 222/W-62.4 (W @ 30 secs visc)
L = Water loss (cc) @ 78 lb/ft³, 185F	L = Water loss (cc) @ 30 secs visc, 185 F
T = Cake (mm) @ 78 lb/ft³ and 185 F	T = Cake (mm) @ 30 secs visc and 185 F
R = Reaction to TSPP (from 30 secs visc @ 1 lb/bbl or 1.7 grams per 600 cc)	R = Reaction to TSPP (from 30 secs visc @ 1 lb/bbl or 1.7 grams per 600 cc)

Notes:
[1] TSPP abbreviates tetra Sodium pyro phosphate, anhydrous.
[2] All clays are thoroughly blunged and mixed in a gear pump or equivalent mixer.
[3] All viscosities are read at 500 cc in, 500 cc out, using a 5/16 in. orifice.
[4] All filter tests are taken at 100 psi from zero to 15 min., using a 3 in. diam cell.
[5] Distilled water for mixing.

We have adopted a form for each type of mud. This allows for more data than are actually required to calculate the merit index, but all of the extra information is nonetheless pertinent, as it is related to the behavior of the clay when it is circulated in an oil well. ★ ★ ★

Oil Employees Comprise Large Segment

"The petroleum industry now employs 1,880,000 men and women," says the API. The survey shows that altogether 9,795,000 workers in the United States are employed by the industries directly related to the petroleum business. The two together represent 23.3 per cent of all persons gainfully employed in the United States. With their wives and families the total is 34,282,000.

FIG. 2

Tide Water Associated Oil Co.
Technical and Research Dept.
Ventura, Calif.

STANDARD TEST OF LIGHT OR COLLODIAL MUDS

How and where sampled _____ Name of clay _____

Supplier _____

Date Sample Received _____ Date Tested _____

DATA FOR MUD INDEX — REMARKS

_____ YIELD @ 30 secs. visc. (bbls. mud/ton dry clay) "Y"

_____ WATER LOSS (cc) "L" } @30 secs. visc. & 185° F. (visc. a constant)
_____ FILTER CAKE (mm) "T" }

_____ REACTION TO CHEMICAL (TSPP) (from 30 secs. visc. @ 1#/bbl.) "R"

_____ INDEX $\frac{(\quad)\text{ "Y" x 1000}}{(\quad)\text{ "L" x (}\quad)\text{ "T" x (}\quad)\text{ "R"}}$

Where: "Y" = Yield in bbls./ton @ 30 secs. visc. = $\frac{222}{\text{Mud Wt.} - 62.4}$

"L" = Water loss (cc) } @ 30 secs. visc. & 185° F.
"T" = Filter cake (mm) }
"R" = Reaction to chemical (from 30 secs. visc. @ 1#/bbl. or 1.7 grams per 600 cc)

DATA FOR USE AS DRILLING OR COMPLETION MUD

_____ Weight (lbs./cu. ft.) @ secs. visc.

_____ Water Loss (cc) } @ 30 secs. visc. & room temp.
_____ Filter Cake (mm) }

_____ Surf. Ten. (dynes/cm using filtrate)

_____ Sand Content (% by weight based upon dry solids)

_____ Salt Content (grains/gal. using above filtrate)

ION CONCENTRATION (lbs. per bbl.)

Ion	Conc.	Ion	Conc.	Ion	Conc.
Nitrate (NO_3)		Calcium (Ca)		Manganese (Mn)	
Nitrite (NO_2)		Carbonate (CO_3)		Sulfate (SO_4)	
Ammonia (NH_3)		Magnesium (Mg)		Chloride (Cl)	
Phosphate (PO_4)		Aluminum (Al)		Sodium (Na)	
Potassium (K)		Iron (Fe)		pH	

Note: All viscosities @ 500 cc in and 500 cc out, through 3/16" orifice. All filter tests taken at 100#/sq. in. from zero to 15 min. using 3" dia cell. TSPP abbreviates Tetra Sodium Pyro Phosphate, anhydrous.

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Preliminary Report on Oil Recovery By High Pressure Gas Injection*

L. P. WHORTON† AND W. F. KIESCHNICK, JR.†

It is well recognized that gas injection-pressure maintenance will yield its maximum oil recovery if initiated early or at least before a reservoir pressure declines below saturation pressure of the reservoir fluid.[1,3] It has been pointed out, however, that often economics demands a delay in beginning such a program.[1,5,7] In any event, increased oil recoveries at higher pressures are attributed to maintenance of optimum values of the reservoir liquid properties, viscosity and formation volume factor (shrinkage factor.)[1,3] In developing these principles, discussions appearing in the literature assume either no change in the virgin oil (and injected gas) properties in the case of pressure maintenance or a gradual deterioration with a pressure decline. The authors propose that the injection of gas at pressures significantly higher than those used in the conventional case will enhance these properties of both the virgin oil and injected gas resulting in higher recoveries.

A few remarks are in order relative to the concepts that led to this proposal. Several years ago attention was directed to the difference in concentration of heavy ends occurring in various condensate systems at similar conditions of temperature and pressure. In Table 1 are shown four condensate systems at varying temperatures and pressures. Contrary to expectations, the system with the lowest gas-oil ratio, System A, does not occur at the highest temperature and pressure. It was at first thought that this anomaly must be accounted for either by the fact that the high gas-oil ratio systems were not saturated or that the boiling range of the condensate was highest in the systems of high gas-oil ratio. When these two factors were studied they did not seem to account for the difference in concentration indicated.

One other factor then was noticed that appears to account for the difference in the concentration of high boiling material in System A, namely the concentration of the material ethane through butane. If we consider the concentration of ethane through butane in the systems, we will see that those which have low gas-oil ratios or high concentrations of hexane plus material also have high concentrations of ethane, propane, and butane. If we calculate the ratios of the sum of ethane, propane, and butane to methane, it will be noted that there is a fairly marked change in this ratio as

TABLE 1

Properties of condensate systems.

Component	A	B	C	D
N_2	9.54	....	....	....
C_1	57.0	79.5	86.3	88.3
CO_2	5.11	1.6	....	....
C_2	6.26	7.6	6.8	5.5
H_2S	6.03	....	....	....
C_3	3.37	4.7	2.5	2.5
C_4	3.03	2.2	1.3	1.4
C_5	2.01	1.0	0.6	0.6
C_{6+}	7.65	5.0	2.5	1.6
Gas-Oil Ratio SCF/STB	8200	13000	29000	43000
Ratio $\frac{C_2 - C_4}{C_1}$	0.26	0.18	0.12	0.11
Temperature (Reservoir) F	228	246	183	179
Pressure (Reservoir) psi	4400	6240	5700	3900

*Presented at the American Petroleum Institute meeting at Oklahoma City, March 29-31, 1949.

†The Atlantic Refining Company, Dallas.

FIG. 1. ASTM assays—Condensate system distillate and crude oil.

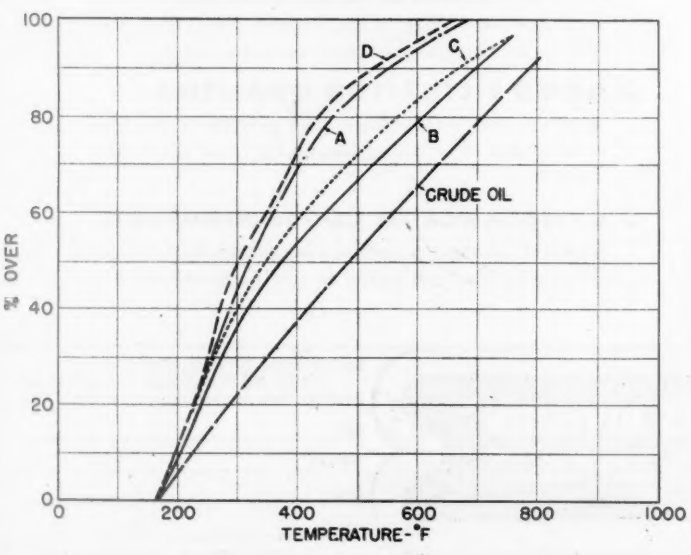
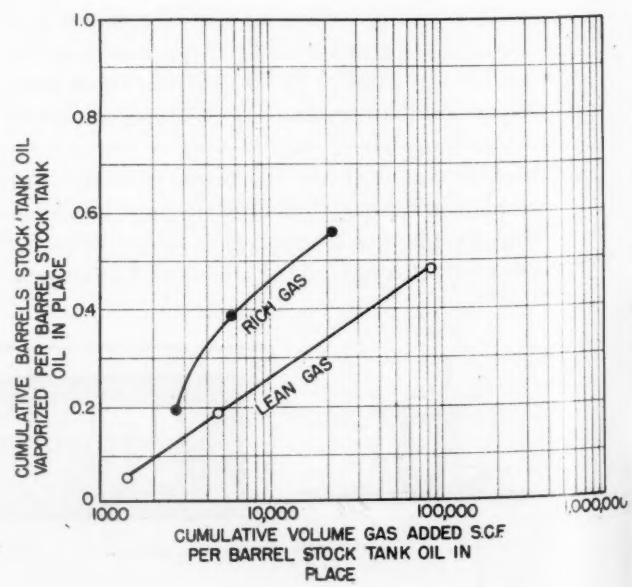


FIG. 2. Static evaporation studies—oil E.



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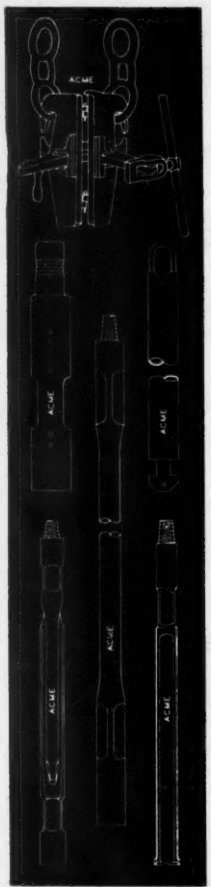

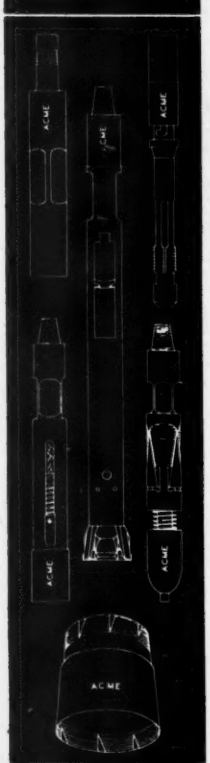

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TABLE 2

Comparison of equilibrium constants (k-values) in retrograde vapors pressures 4000 psi.

System	A	B	D*	Katz[6]
Temperature	228 F	246 F	179 F	250 F
Component				
C_1	1.55	1.7	(1.7)	1.7
C_2	0.98	1.13	(1.1)	1.0
C_3	0.76	0.86	(0.84)	0.79
C_4	0.61	0.68	(0.65)	0.60
C_5	0.49	0.51	(0.50)	0.48
C_{6+} (Calculated from dewpoint)	0.307		(0.055)	

* Estimated.

we go from the richest system to the leanest system. System A, the richest, has a ratio of 0.26, and this ratio falls to a value of 0.11 for the System D, which is by far the leanest of those shown.

Some experimental equilibrium constants were available for Systems A and B. These are shown in Table 2. It will be noted that the constants for components methane through pentane are fairly similar. If these values are used in System D, which is at its dew point, and a value for hexane plus calculated, it is seen that there is a marked difference in the hexane plus k values in Systems A and D. It would appear, then, that when methane is mixed with heavy material, the heavy material has a low k value, but when material such as ethane, propane, or butane is mixed into the system it has a marked effect on raising the k value of the hexane plus material. This effect, the degree of which is surprising, occurs because the new material added is highly soluble in both the light component and the heavy component and tends to make the overall system more nearly miscible.

The thought then occurred that if a system of methane mixed with reasonably moderate concentrations of ethane, propane, and butane could be injected into a reservoir, this so-called rich gas might be capable of dissolving extremely large amounts of the crude oil. Such a mixture of crude oil and natural gas at high pressures should result in retrograde evaporation of a portion of the oil to give a vapor phase similar to that existing in a gas condensate system in the retrograde region. Consequently the higher the pressure of the system, the greater should be the amount of heavier constituents from the oil in the vapor phase.[8] With this in mind, attempts were then made to calculate the amount of crude oil which could be evaporated by this type of system compared with a system where smaller amounts of ethane through butane occurred.

For this calculation the rich gas was taken to be the same as the methane through butane fraction of System A, the lean gas as the methane through butane fraction of System D, and the crude oil as that shown in Fig. 1. For this calculation it was assumed that half of the crude oil in the reservoir had been displaced by some other means and that the voids left by this displacement were filled with the gas in question. Equilibrium data used for the calculation are shown in Table 2, where the C_{6+} k value for Systems A and D were calculated from knowledge of their dew points. Although experimental k values were not available for components methane through pentane in System D, these were estimated as shown.

Using these equilibrium constants and assuming that the fraction of the heavy ends of the crude oil that distill over at temperatures higher than the end points of the condensate in Systems A and D is inert and has a zero k value, the amounts of these two synthetic systems that would remain liquid under reservoir conditions were calculated. The results of these calculations are listed in Table 3, and they show that a gas containing as much ethane, propane, and butane as System A will evaporate 45 per cent of the pentane and heavier fraction of the crude oil. Using a gas with the ethane, propane, and butane content of the lean System D, only 19 per cent would be evaporated.

With these results experimental work was carried out, using both static and dynamic systems. As will be discussed below, the effect of composition of the gas became less important as dynamic results became available. This presumably arose from the fact that with most crude oils taken from

TABLE 3

Calculated crude residual oil evaporation with high pressure gas.

	Gas from A	Gas from D
$(C_2 + C_3 + C_4)/C_1$ Ratio	0.26	0.11
Per cent crude oil heavy ends inert	22.9	26.1
Volume per cent crude oil C_{5+} —Evaporated	45.0	18.8
Cubic feet of gas added per bbl C_{5+} evaporated	11,150	30,900

TABLE 4

Properties of reservoir oil E.

Composition		
Component	Mol per cent	Bubble-point 2780 psi at 140 F
C_1	44.8	Solution gas-oil ratio at 2780 ps (one stage-flash) 1750 SCF/STB
C_2	13.0	
C_3	9.5	
C_4	6.3	Formation volume factor at 2780 psi 1.88 R.B./STB*
C_5	3.1	
C_6	3.8	Viscosity at 2780 psi 0.30 centipoises
C_{7+}	19.5	
	100.0	
Properties of C_{7+} fraction:		Average molecular weight 200 specific gravity at 60 F 0.827

* Reservoir barrels/stock tank barrel.

TABLE 5

Composition of injection gases.

A. Lean gas.

Component	Composition Mol Per Cent
C_1	87.9
C_2	11.6
C_3	0.5
C_4	....
C_5	....
C_6	....
C_{7+}	....
	100.0

B. Rich gas.

Component	Composition Mol Per Cent
C_1	72.4
C_2	16.4
C_3	8.0
C_4	2.2
C_5	0.6
C_6	0.1
C_{7+}	0.3
	100.0

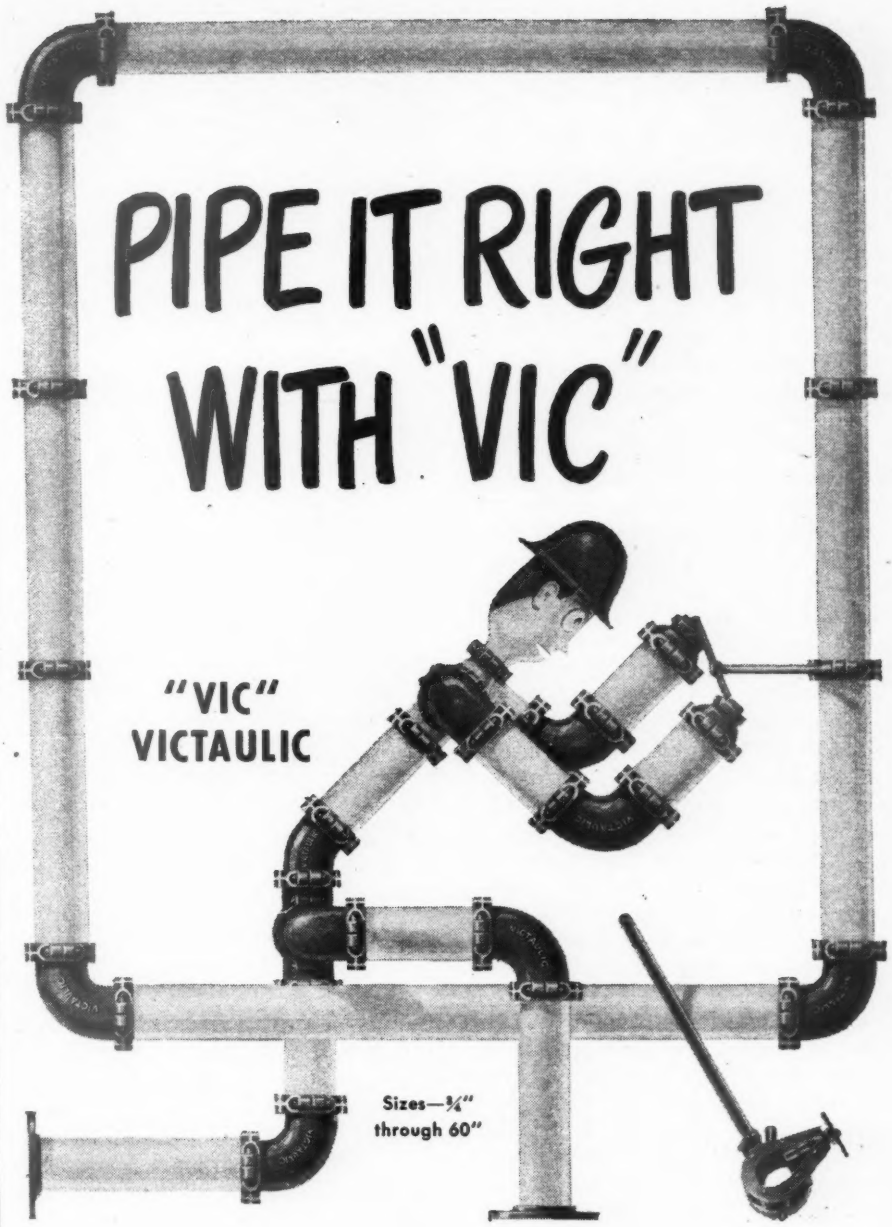
Molecular Weight of C_{7+} approx. 105.

deep reservoirs there occur large quantities of the ethane through pentane material, which enriches the gas with respect to these components irrespective of its original composition.

Static Experimental Work

Evaporation Studies. Static experiments were designed to demonstrate the evaporation effects predicted by the calculations described above. For these experiments a 2780 psi bubble point oil, Reservoir Oil "E" (Table 4), was used along with two gases in the two cases studied. One of these gases, which will be referred to as "lean" gas, contains mostly methane, some ethane, and a trace of propane. The other gas, which will be referred to as "rich" gas, is a 300 psi separator gas that contains moderate amounts of propane and heavier components. Table 5 describes these gases more fully.

In order to determine the amount of Oil E the given gas would evaporate at the arbitrarily chosen pressure of 4000 psi, a mixture of the oil and gas was brought to equilibrium at 4000 psi and the resulting vapor was analyzed. The remaining oil was contacted with the same gas twice more at 4000 psi. The proportions of gas and oil involved in these successive contacts were arbitrary, the first contact involving a combination that was mostly oil, the second contact a 50-50 mixture of oil and gas, and the third contact a mixture that was mostly gas. This series of contacts was made for each of the two gases. Results of these tests are presented in Fig. 2, in which the cumulative barrels of stock tank oil vaporized per barrel of stock tank oil in place is presented as a function of the amount of gas that contacted the oil. It is noteworthy that a considerable fraction of the contacted reser-



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voir oil was evaporated and that for a given amount of gas the rich gas was a more efficient solvent for the reservoir oil.

Reservoir Volume Ratio. These experiments emphasized another fact hitherto unconsidered. It was discovered that the "enriched" gas resulting from the first contact was considerably more soluble in the undersaturated Oil E than was the virgin 4000 psi gas.[9] Solution of the enriched gas in Oil E at 4000 psi yielded a highly expanded system that contained appreciably more gas than a similar system made with unenriched gas. Fig. 3 describes the details and results of this experiment. The term "reservoir volume ratio" has been chosen to describe the change in volume in reservoir oil brought about by the solution of the enriched gas. If the virgin 2780 psi bubble point Oil E were flashed to atmospheric pressure, the ratio of the volume of the reservoir oil at 2780 psi and 140 F to the volume of the stock tank oil obtained by the flash separation would be the well known formation volume factor. When Oil E was contacted with 4000 psi enriched gas it was found that the volume was increased beyond that expected from merely raising the bubble point. If such an expanded oil were to be stabilized to atmospheric pressure, the liquid remaining would be of a different composition from the stock tank oil obtained by stabilization of uncontacted Reservoir Oil E. This results from the fact that the gas that dissolves in the oil had been enriched with condensable hydrocarbons by its previous contact. In order to provide a comparison between the volume of the reservoir oil containing a given amount of stock tank oil before contact with an enriched gas and the volume of reservoir oil containing the same amount of original stock tank oil after such a contact, the term "reservoir volume ratio" has been adopted. Reservoir volume ratio is defined as a ratio of the volume of the reservoir oil in which the enriched injected gas has been dissolved to the volume of original stock tank oil in the reservoir oil.

The application of this reservoir volume ratio effect in an oil reservoir would involve the injection of a high pressure gas of suitable composition into an oil reservoir that contains an undersaturated oil. The injected gas enriched by retrograde evaporation would dissolve in the undersaturated oil at the interface and swell it up, thereby reducing to a considerable extent the content of original stock tank oil in a given reservoir volume of saturated oil. The residual oil left

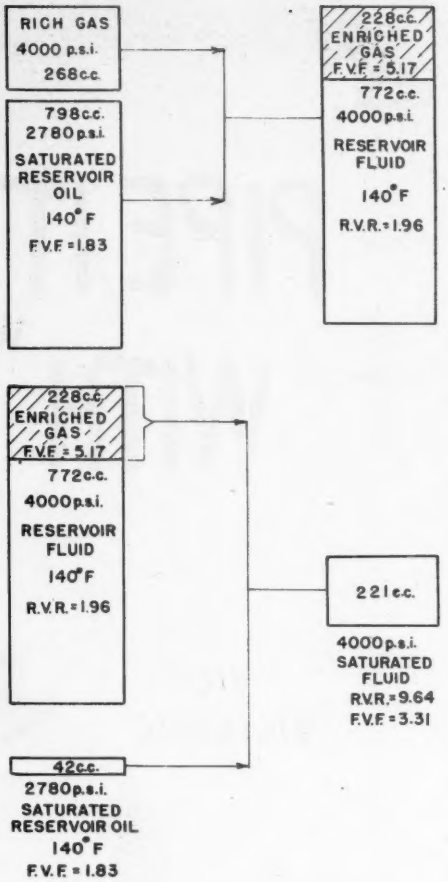

FIG. 3. Reservoir volume ratio study.

behind the interface would consist of this diluted, swollen oil, which for a given reservoir volume of oil would contain considerably less of the heavier oil fractions than the same amount of virgin reservoir oil. The intermediates present in the expanded oil and which account for a large portion of the additional volume can subsequently be evaporated by additional injected gas.

Dynamic Displacement Studies

The experimental determination of the evaporation and solubility effects involved in the displacement of oil by high pressure gas in a reservoir is extremely difficult with static experiments. The displacement process is a complex one in that solution and evaporation effects set up a gradient of fluid properties unlike the more conventional gas displacement operation that involves relatively constant fluid properties. In view of these considerations, dynamic experiments were designed to study the process under actual flowing conditions.

Equipment. The laboratory equipment used for the dynamic studies was built for pressures up to 5000 psi and for a range of temperatures up to 250 F. The main elements of this equipment are a 25 ft unconsolidated sand core reservoir, a high pressure visual separator, a high pressure reservoir for mixing and storing reservoir fluid to be studied, and a reservoir for storing and compressing high pressure injection gas. Fig. 4 is a schematic layout of these units.

A 140-270 mesh sand having a permeability of 1.2 darcies and a porosity of 48 per cent was used (total void volume 4250 cc). The sand was contained in a 25-ft section of 2-in. heavy seamless steel tube, which was jacketed with a thermostated oil bath. A high pressure visual separator was provided for observation of the effluent under reservoir pressure and temperature. A visual atmospheric separator followed the rate control valve and was connected to a gas meter and oil stock tank. The sand core was connected to the charging chambers by stainless steel tubing through a manifolding system. Various valves and gages were placed in the system at appropriate points to allow sampling, flow control, etc.

In operation the sand reservoir was evacuated and filled with an atmospheric stabilized "dead" oil at the pressure and temperature of the run to be made. Reservoir fluid to be studied was pumped in, displacing the "dead" oil, thereby setting up a system to be used in the gas displacement experiments to follow.

Systems Studied. The reservoir oil used in most of the experimental work had a bubble point of 2780 psi at 140 F and was obtained from a reservoir of approximately 8500 ft depth. This oil is further described in Table 4, where it is identified as Reservoir Oil E. Although it would be difficult to point to a "typical" high pressure reservoir oil, it is felt that Reservoir Oil E is certainly not an unusual type system and results of displacement studies involving it might be extended in principle to other systems.

Two other reservoir oils used in the work were obtained by recombining separator gas and oil phases of the above system in different proportions to give reservoir oils with bubble points of 1200 psi and 4180 psi. These oils are described more fully in Table 6, where they are referred to as Reservoir Oils F and G, respectively.

As in the static studies, two injection gases, rich and lean, were used. These gases have been described in Table 5.

Experimental Results. Results of high pressure gas displacement runs chosen for the first phase of the evaluation of this process are reported in this paper. These runs were chosen primarily to evaluate the effect of

TABLE 6

Properties of reservoir oils F and G.

A. Reservoir oil F.

Component	Composition Mol Per Cent	Bubble-point 1200 psi at 152 F
C_1	22.6	Solution gas-oil ratio at 1200 psi 380 (one stage-flash) SCF/STB
C_2	5.1	
C_3	3.6	
C_4	4.8	Formation volume factor at 1200 psi 1.22 (one stage-flash)
C_5	4.9	
C_6	5.0	Viscosity at 1200 psi 0.85 centipoises
C_{7+}	54.0	
	100.0	
Properties of C_{7+} fraction:		Average molecular weight—200 specific gravity at 60 F—0.827

B. Reservoir oil G.

Component	Composition Mol Per Cent	Bubble-point 4180 psi at 140 F
C_1	44.5	Solution gas oil ratio at 4180 psi 2940 (one stage-flash) SCF/STB
C_2	13.4	
C_3	14.0	
C_4	5.1	Formation volume factor at 4180 psi 2.50 (one stage-flash)
C_5	2.8	
C_6	2.3	Viscosity at 4180 psi 0.18 centipoises
C_{7+}	17.9	
	100.0	
		Average molecular weight—200 specific gravity at 60 F—0.827

pressure upon the process and to study to a limited extent the effect of the hydrocarbon systems involved. Accordingly, a series of runs at various pressures and at the same temperature involving Reservoir Oil E were made using each of the two injection gases. It was felt that as a more or less typical reservoir fluid had been chosen for first study, the reservoir oil composition could be kept constant in the initial work, and the effects of pressure and gas composition evaluated.

Using the lean gas and the 2780 psi bubble point Reservoir Oil E, a series of runs was made at pressures of 2780, 3500, and 4000 psi. The first run at the bubble point of the fluid, 2780 psi. was thought of as representing a conventional gas displacement operation which is carried out at low pressures. At these conditions essentially none of the evaporation and solution effects expected at high pressures should occur. This run should then be a yardstick, and its recovery could be calculated by existing methods that consider a conventional gas displacement mechanism. The two higher pressures were chosen because they might be practicable in field operations and are probably high enough to demonstrate the effectiveness of the process.

Fig. 5 compares the gas-oil ratio recovery histories of the lean gas displacement of oil at these pressures. In the displacement at 2780 psi it is seen that an early gas breakthrough (13 per cent recovery) occurred and that most of the 43 per cent ultimate recovery was attained in the two phase production period between gas breakthrough and the occurrence of a 30,000 std cu ft per stock tank barrel (SCF/STB) abandonment gas-oil ratio. Stock tank oil produced during this run was essentially constant in composition. Displacement of the same reservoir fluid at 3500 psi presents a more favorable history. In this case the gas-oil ratio began to rise at 25 per cent recovery, and gas breakthrough occurred at 31 per cent recovery. Production between these two recoveries will be referred to as the oil transition zone, during which time the gas-oil ratio steadily increased and the stock tank oil composition varied slightly. After the gas breakthrough, the stock tank oil composition varied more rapidly until at the abandonment gas-oil ratio (62 per cent recovery) the only liquid being recovered was the condensate carried by the gas.

Displacement at 4000 psi yielded a recovery history somewhat similar. The corresponding values for recovery at the end of virgin reservoir oil production, gas breakthrough, and ultimate recovery are 40, 58, and 70 per cent, respectively.

Another almost parallel series of runs was made using rich gas as the injection gas. The bubble point run at 2780 psi was not repeated in this case as it was assumed that little evaporation and solution effect would occur and the recovery should be essentially equivalent to that obtained using lean

FIG. 4. Schematic layout of equipment.

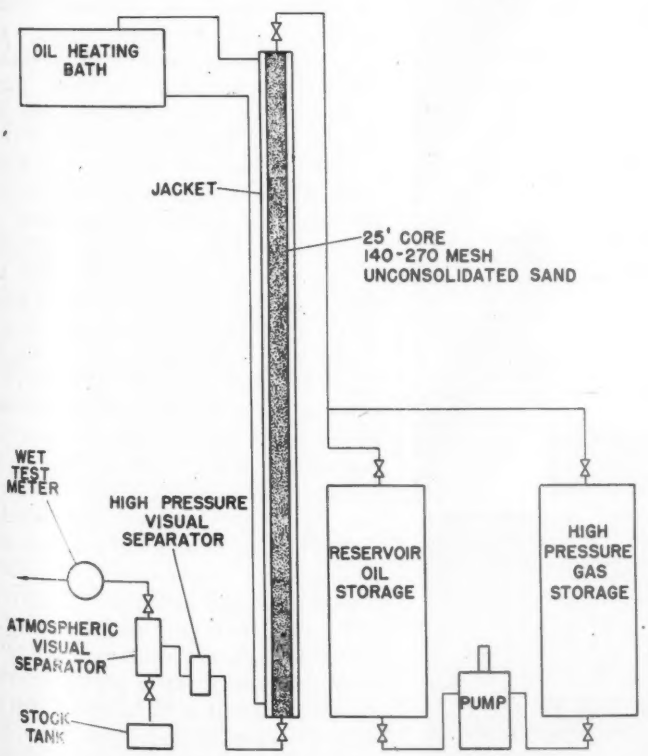

FIG. 5. Gas-oil ratio—Recovery history displacement of oil E by lean gas.

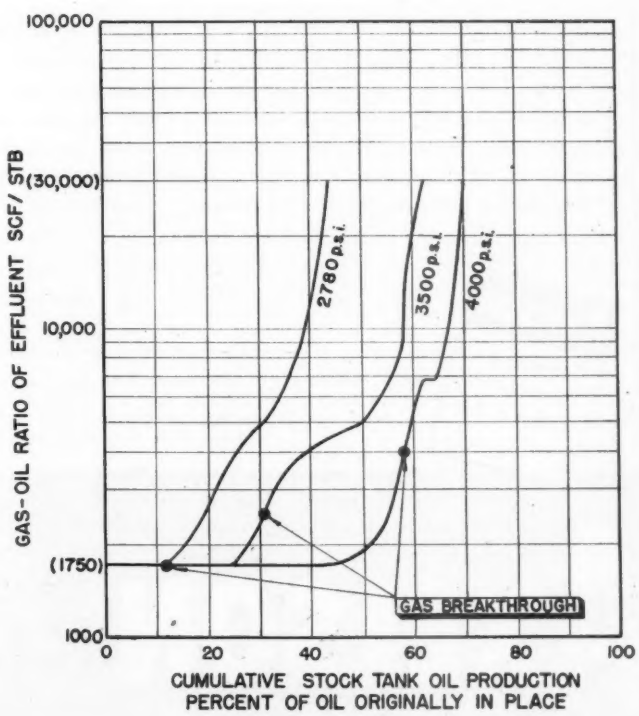

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TABLE 7

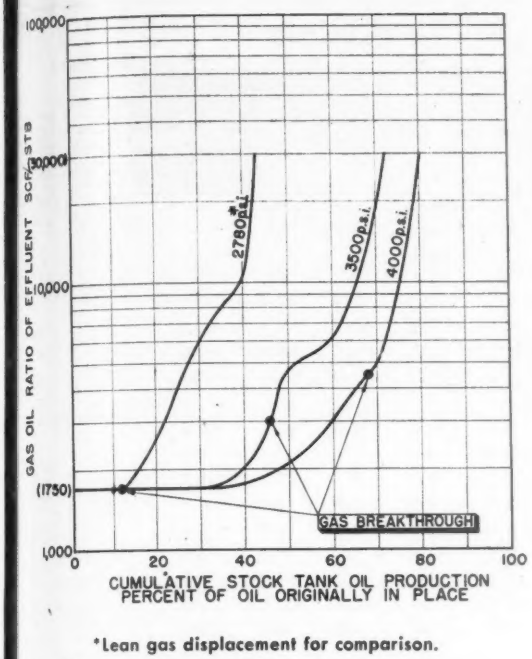
Results of dynamic runs.

Run No.	Pressure PSI	Reservoir oil	Gas	Stock tank oil recovery	Total gas injected at 30,000 GOR
					SCF Injected Gas
				Per cent at 30,000 GOR	Cu Ft Pore Space
1	2780	Oil E	Lean	43	454
2	3500	Oil E	Lean	62	400
3	4000	Oil E	Lean	70	393
4	3500	Oil E	Rich	72	400
5	4000	Oil E	Rich	80	413
6	1200	Oil F	Lean	40	460
7	4180	Oil G	Lean	69	453
8	4180	Oil G	Rich	76	420

gas. High pressure runs were made at 3500 and 4000 psi in this series.

Fig. 6 compares the gas-oil ratio recovery histories of the rich gas displacement at the two pressures (2780 psi lean gas run shown for comparison). These displacements yielded recovery histories similar to those of the lean gases, but the process is significantly more efficient, as will be noted. At 4000 psi the recovery was 80 per cent at 30,000 SCF/STB gas-oil ratio.

In addition to these two series of runs, a pair of runs was made at 4200 psi in which a reservoir fluid with a 4180 psi bubble point (Reservoir Oil G) was displaced by rich and lean gas, respectively. Another run involving a 1200 psi bubble point reservoir fluid (Reservoir Oil F) displaced with lean gas at 1200 psi was made to verify that essentially the same recovery would be obtained under these conditions as in the case of the displacement of Reservoir Oil E at its bubble point. It was felt that in the absence of evaporation and solubility effects associated with the high pressure gas injection process these two runs should have about the same recovery. Table 7 summarizes the pertinent data for all the runs described above. A convenient review of the several series of runs is presented by Fig. 7, in which per cent recoveries are presented as a function of the operating pressures. It can be shown that below 3000 psi the recoveries are approximately those that might be predicted by conventional gas drive mechanism calculations. Displacement of Oil F at 1200 psi, e.g., recovers around 40 per cent, which is almost the same recovery as that obtained with 2780 psi Oil E. At pressures above 3000 psi, however, the recovery increases significantly with pressure. The increase in pressure accounts for increased retrograde evaporation and accompanying favorable miscibility and viscosity effects. Probably higher recoveries would have been obtained at even higher operating pressures. It is to be noted that at high pressures higher recoveries are obtained by using the richer of the



*Lean gas displacement for comparison.

FIG. 6. Gas-oil ratio—Recovery history displacement of oil E by rich gas.

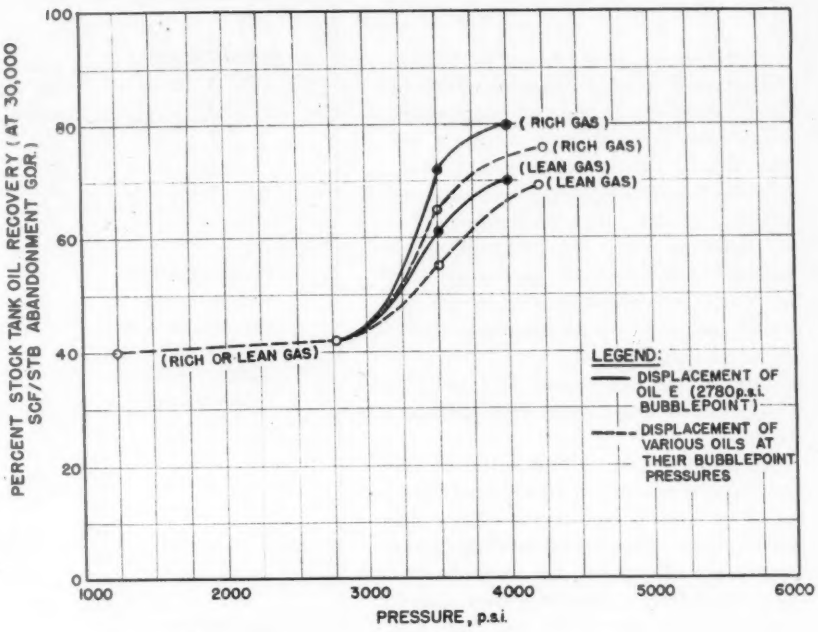


FIG. 7. Effect of pressure and composition on recovery reservoir oils E, F, and G.

two injection gases. This result is consistent with the reasoning presented earlier in the paper. It is seen that at high pressures there is some recovery advantage in displacing an undersaturated reservoir oil rather than a high bubble point oil at the same pressure, although both cases show high recoveries. This difference can possibly be explained by the occurrence in the undersaturated cases of the "Reservoir Volume Ratio" effect described previously.

Discussion of Results

Mechanism Involved. It is interesting to speculate as to what happens when high pressure gas is injected into a porous medium containing oil at conditions similar to those in a natural reservoir. At first the injection gas pushes oil out of the medium in amounts determined by the relative permeability-viscosity relationships.[4] If the oil is undersaturated, solution of the gas in the oil is caused by the difference in reservoir and saturation pressures. An increase in the formation volume factor with its attendant effects takes place. Also, the reservoir volume ratio effect discussed previously begins to play a part. In this case it is conceivable that the volume of reservoir oil is many times the volume of equivalent stock tank oil originally in place in a given pore. In any event, the displacing gas becomes richer in condensables and the oil becomes richer in light ends. It has been shown experimentally that the oil immediately before the oil-gas interface appearing in the effluent from a dynamic system and the gas immediately following this interface have properties very much closer together than the original gas and oil. Reference is made to Fig. 8, which shows schematically the change in fluid properties from virgin oil, through the transition zone to injected gas. It is noteworthy that near the oil-gas interface the gas to liquid viscosity ratio is .5, whereas that of injected gas to virgin oil is .1. This "coming together" of the properties of gas and oil at the interface requires the occurrence of the transition zone shown in the figure. The length of this transition zone is not known for different porous systems. It is obvious that any slight degree of channelling will have an effect on the length of this zone. In the absence of channelling, it would appear that the zone is primarily controlled by the relative permeabilities. In any event, the 25-ft porous system used in the experimental work is sufficiently long to set up a transition zone in an unconsolidated sand. It is known that there was some channelling in this system, and it is likely that where channelling does not occur that the transition zone would be relatively short. It is noteworthy that the approach in properties of the liquid and gas at the interface has a marked effect on the displacement phenomenon, particularly with respect to viscosity,[2, 4] which along with the relative permeability controls the ratio of the flowing phases.

In the extreme there is no phase change in the effluent stream of the dynamic runs. In other words, the properties of the effluent change from those of an obvious liquid to those of an obvious vapor. During this transition the gas-oil ratio increases from the saturation value of the liquid originally in place to an infinitely high gas-oil ratio corresponding to the injected gas. In the case where no phase change occurs it would appear that the process was then comparable to one in which a miscible liquid was used to wash the porous medium of the oil in place. It should be comparable, for example, to washing the medium with a liquid such as propane, which is miscible with the liquid in place, and very high recovery should obtain.

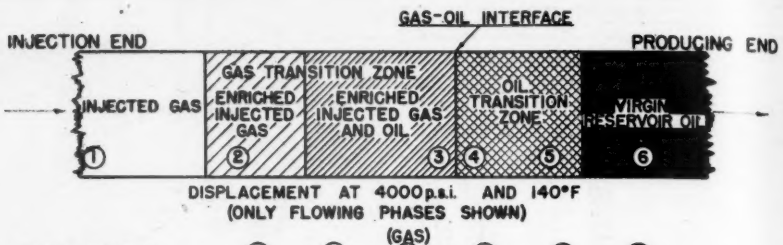
In the case of a saturated oil displaced at high pressure, enrichment of the displacing gas by evaporation and the resulting viscosity and miscibility effects result in recoveries approaching those of the undersaturated case. In this case, however, there is no reservoir volume ratio effect, which probably accounts for the difference in recoveries between the saturated and undersaturated cases at the same pressure. (Fig. 7) As in the undersaturated case recovery may be effected without phase change in the effluent stream (Run 8, Table 7).

The effect upon the mechanism of several variables, held essentially constant in the work to date, remains to be completely evaluated. Examples of these are the effect of the properties of the medium on the length of the transition zone and the sweepout efficiency, the effect of temperature, and the ef-

fect of the composition of the reservoir oil.

Channelling. It is known that channelling will have a marked effect on the process described. If channelling is extreme, then little or no effect will take place, the injected gas passing through the channel with no beneficial results. On the other hand, the effect of slight amounts of channelling is difficult to estimate. It is known that the runs described above were adversely affected by channelling to the extent that at least 10 to 15 per cent of the oil in place was left behind, which could have otherwise been recovered.

Recent work in which some of the key runs reported in this paper were repeated under conditions that were designed to reduce channelling, gave recoveries about 10 per cent higher than comparable runs reported above. For example, the 4000 psi rich gas run displacing Oil E gave an 80 per ent recovery where channelling was known to be present, but on the modified core a recovery of 88 per cent was obtained. Further attempts are being made to determine experimentally the effects of channelling on this mechanism.

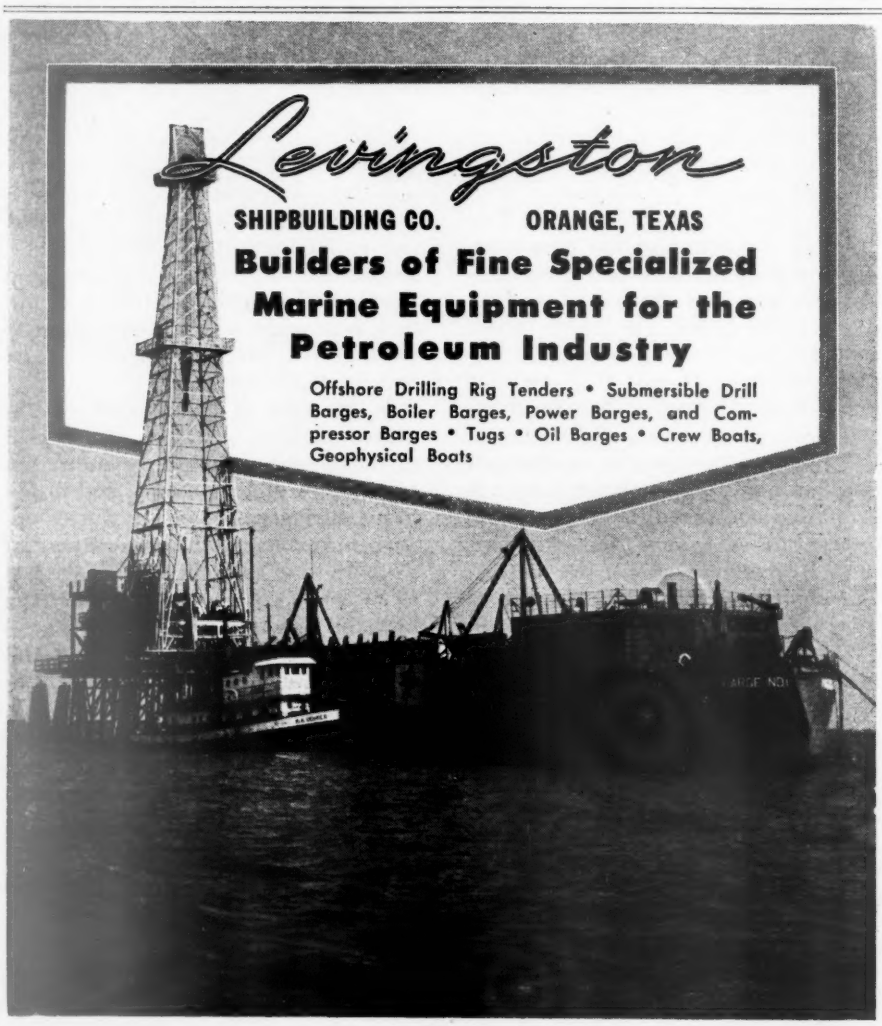


DISPLACEMENT AT 4000 p.s.i. AND 140°F
(ONLY FLOWING PHASES SHOWN)
(GAS)

FLUID LOCATION		①	②	③	④	⑤	⑥
VISCOSITY CP.		0.03	0.032	0.070	0.14	0.18	0.25
AVERAGE MOL WEIGHT		21.9	23.6	33.8	40.2	59.6	63.8
GAS OIL RATIO SCF/STB		∞	60,000	8000	4500	2300	1700
BUBBLE POINT p.s.i.		—	—	—	4000	3000	2780
COMPOSITION							
	C_1	72.4	71.0	62.0	56.3	45.5	44.8
	C_2	16.4	15.8	14.8	17.4	13.1	13.0
	C_3	8.0	7.7	8.7	8.7	10.9	9.5
	C_4	2.2	2.4	4.0	3.6	6.0	6.3
	C_5	0.6	2.0	2.0	2.2	3.5	3.1
	C_6	0.1	0.3	1.2	1.8	2.6	3.8
	C_7^+	0.3	0.8	7.3	10.0	18.4	19.5
	TOTAL	100.0	100.0	100.0	100.0	100.0	100.0
MOL WEIGHT	C_7^+	100	120	150	170	192	200

FIG. 8. Schematic cross-section of fluid properties displacement of oil E by rich gas run 8.

Factors Influencing Additional Recovery. There appear to be, then, three important factors that govern the additional recovery obtainable with high pressure gas over that expected from conventional low pressure gas sweep: (1) The solubility effects, which in their simplest forms can be looked upon as merely an evaporation of the oil into the gas and an increase in the formation volume factor of an undersaturated oil; (2) the viscosity effect, which would make the two phases flow in proportions more favorable to liquid due to decrease of liquid and increase of gas viscosities; and (3) the reservoir volume ratio effect, which can only occur with undersaturated systems. Viscosity effect is obviously dependent on the solubility effect since it comes as a result of gas dissolving in oil and oil in gas. The solubility effect accounts not only for evaporation of large quantities of oil into the gas but, under some circumstances, also accounts for the occurrence of a miscible system as described above. If this can be obtained in the reservoir, it would appear that in the absence of channelling rather striking results in high recoveries of oil would come about.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Conclusions

1. High pressure gas will recover at reasonably low gas-oil ratios appreciably more oil from a porous medium than can be recovered with conventional low pressure gas sweep, and in most cases significantly more than water flooding.

2. Prerequisites for the application of the process include:

a. High pressures—Available data

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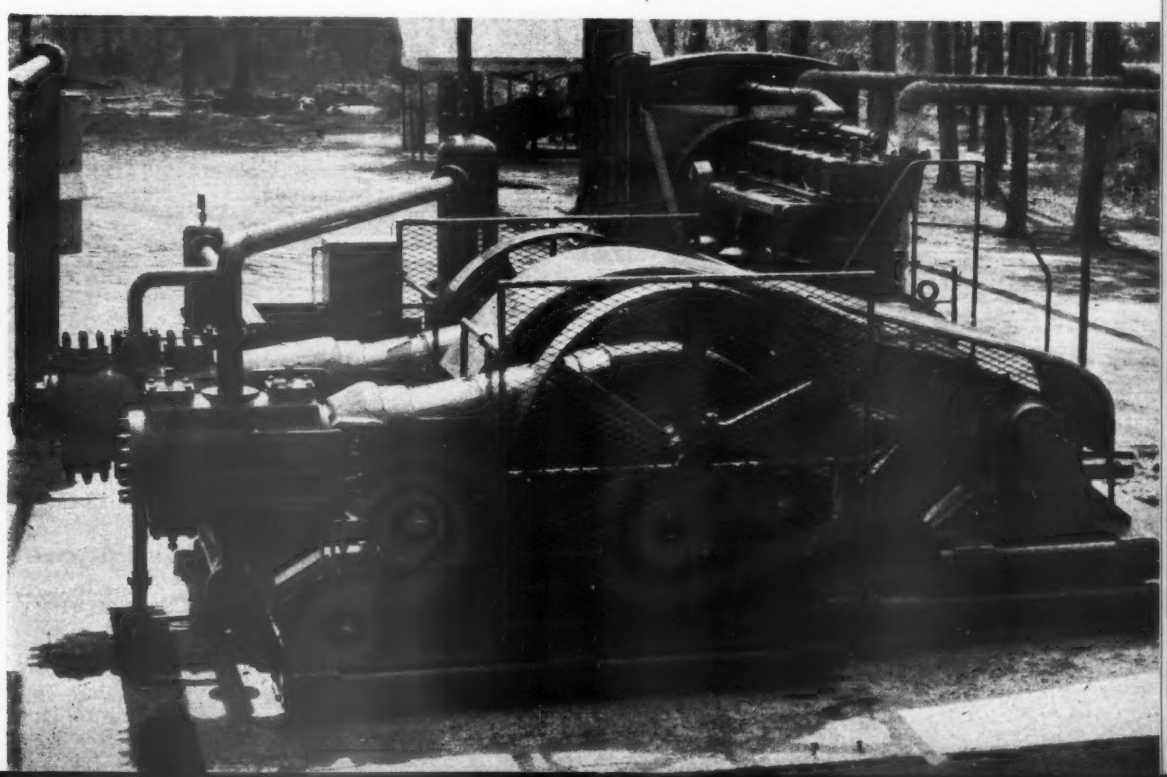

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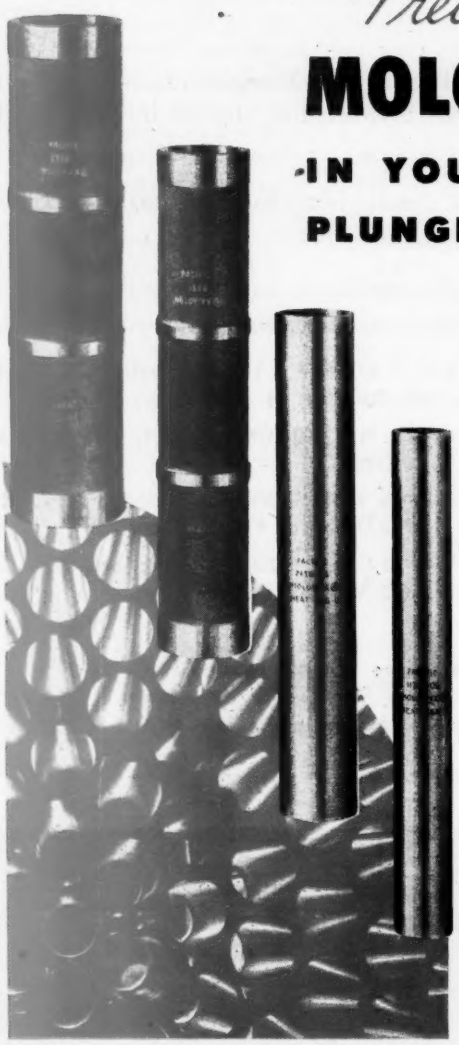

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indicate that pressures in excess of 3000 psi are required.

b. Large volumes of gas—Sufficient gas at the pressure in question to replace the volume of oil recovered must be injected.

c. Small amount of channelling—Channelling is reduced in the high pressure process below that experienced with low pressure gas sweep because of the more advantageous viscosity relationship, but the high pressure process may be affected more adversely for a given amount of channelling because intimate contact is required for the solubility effects involved.

d. Sufficient concentration of intermediates in the reservoir fluid—Significant amounts of intermediates (approximately ethane through heptane) are required to provide solubility effects necessary to the process. This condition will probably always obtain in deep reservoirs.

3. The mechanism of additional recovery is governed by:

a. The retrograde solubility effects that account for enrichment of the gas with intermediate boiling range hydrocarbons.

b. The subsequent solution of these intermediates in the "downstream" oil, with attendant swelling of this oil to a high volume relative to its original.

c. The viscosity change as a result of enrichment of gas and swelling of oil. These viscosities are much closer together than occur in the virgin state, enhancing the displacement efficiency.

Acknowledgment

The authors wish to acknowledge the contributions of E. R. Brownscombe to the concepts and critical evaluation involved in this work.

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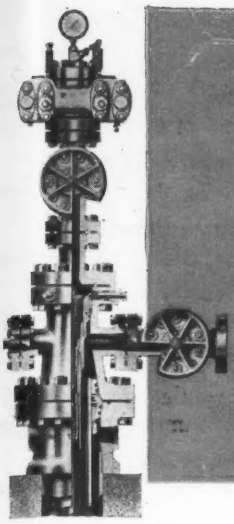

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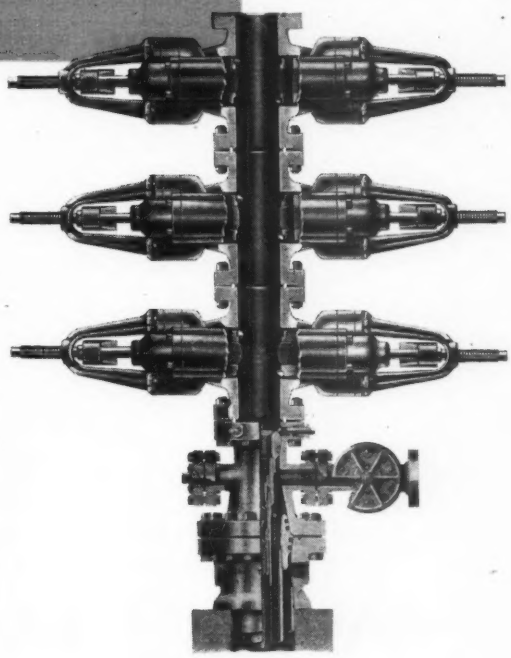

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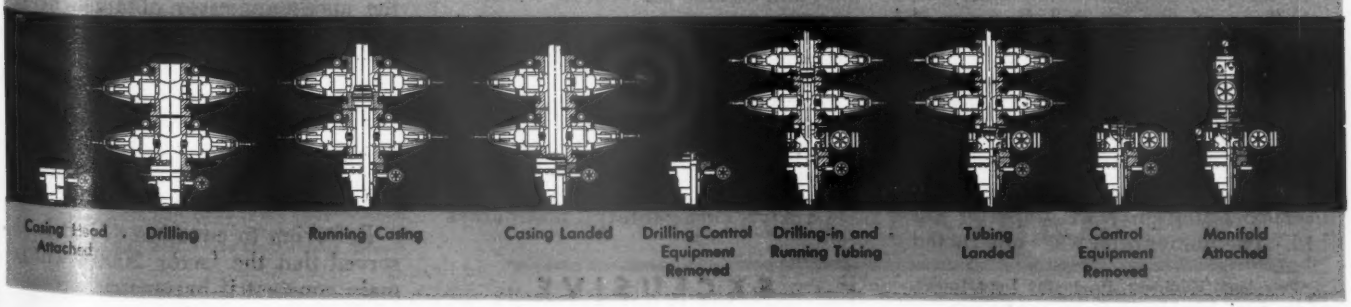


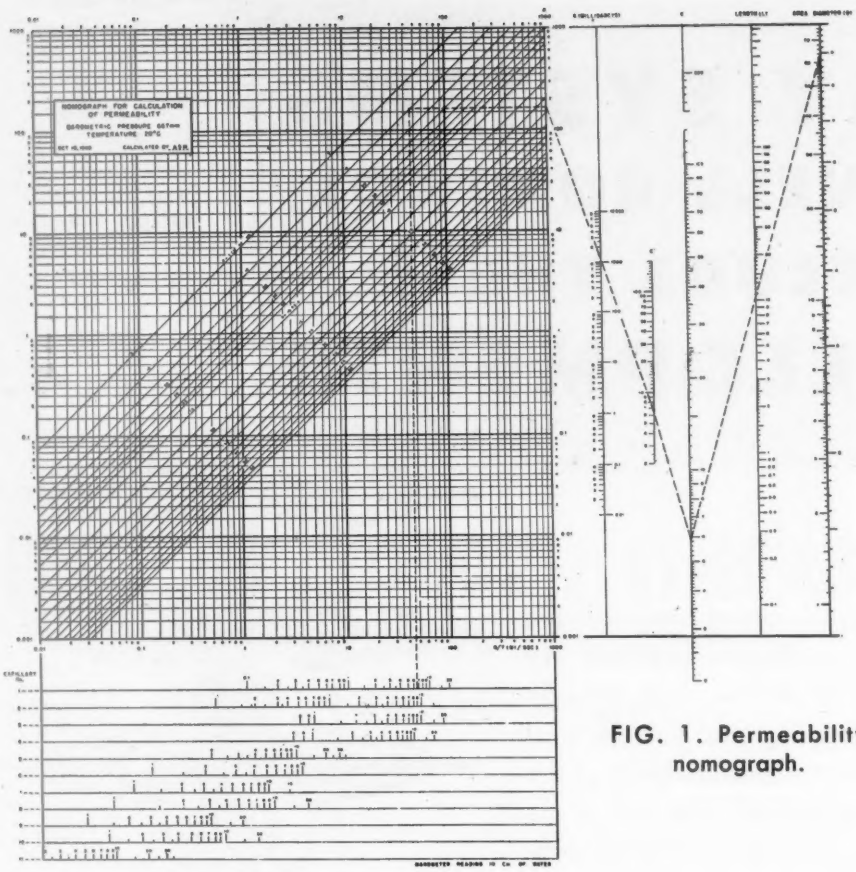


FIG. 1. Permeability nomograph.

A Rapid Method for Permeability Calculations

A. S. McLATCHIE*

THE determination of permeability of a core specimen involves the measurement of the rate of flow of a fluid through a measured core under a measured differential pressure. As a routine method, air is commonly used;[1] measurements are taken of input air pressure, barometric height, gas flow rate, length and diameter of core, temperature of air, and the corresponding viscosity.

The nomographic method of calculation described in this article was designed for the techniques and apparatus used in the Petroleum Engineering Laboratory of Imperial Oil Ltd.[2] The nomograph was constructed primarily to speed calculation and thereby increase the throughput of cores as well as to keep mathematical errors to a minimum.

Several nomographs have been devised for the calculation of permeability[3,4] but these have been found to be too cumbersome for routine work.

The Darcy equation for permeability calculations is as follows:

$$K = \frac{Q}{T} \times \frac{L}{A.\Delta P} \times \frac{B}{Pm} \times Z \times 1000 \quad . \; . \quad \text{eq. (1)}$$

Where:

K = Permeability .. millidarcys

Q/T = Gas flow rate (at P_2) Cm^3/Sec.

L = Length of Core.....cm.

A = Area of core.....cm^2

ΔP = Pressure differential Atmospheres

Pm = Mean—Pressure Atmospheres

Z = Viscosity of air Centipoises

Let:

B = P_2 (outlet pressure) = atmospheric pressure

P_1 = inlet pressure Atmospheres

Then:

$$Pm = \frac{(P_1 + P_2)}{2}$$

$$\Delta P = (P_1 - P_2)$$

Rewriting equation (1)

$$K = \frac{Q}{T} \times \frac{L}{A} \times 2 \times \frac{P_2}{(P_1 - P_2)\,(P_1 + P_2)} \times Z \times 1000$$

. . . . . eq. (2)

or

$$K = \frac{Q}{T} \times \frac{L}{A} \times \frac{P_2}{(P_1^2 - P_2^2)} \times Z \times 2000 \text{ millidarcys} \quad . \quad \text{eq. (3)}$$

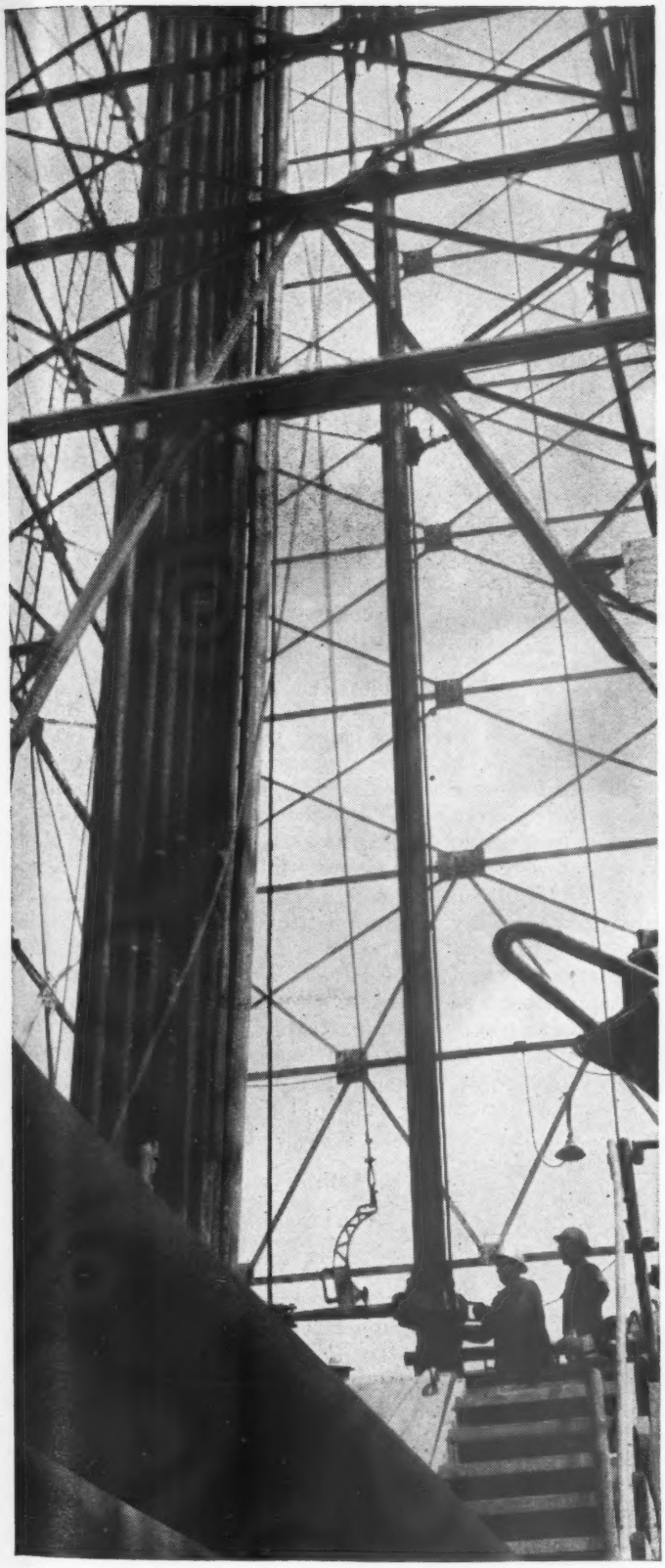
The capillary orifice meters used for measuring the flow rates of air were calibrated as described in (5). The final result of this calibration was reduced to a form in which values of Q/T were obtainable directly from the water manometer deflections. The outlet pressure (P_2) in equation (3) is equal to the barometric pressure plus the differential pressure on the flow meter. The input pressure (P_1) is equal to the barometric pressure plus the gauge (or mercury manometer) pressure on the input air. The barometric pressure was assumed to be constant for any one elevation (6). Errors were introduced by making this assumption, the actual magnitude of the error being dependent on the difference between actual and average barometric pressures at the time of the determination. These differences can be shown to be relatively small, the maximum error obtained over a full range of barometric pressures being less than 5 per cent.

The construction of the monograph was based on the assumption that the average laboratory temperature was 20 C. Refer to capillary flow meters—(5).

Referring to equation (3) it is observed that the factor 2000Z will remain constant if barometric pressure,

*Petroleum Engineer, Producing Department, Imperial Oil Ltd., Calgary, Alberta, Canada.

EXCLUSIVE



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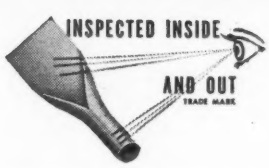

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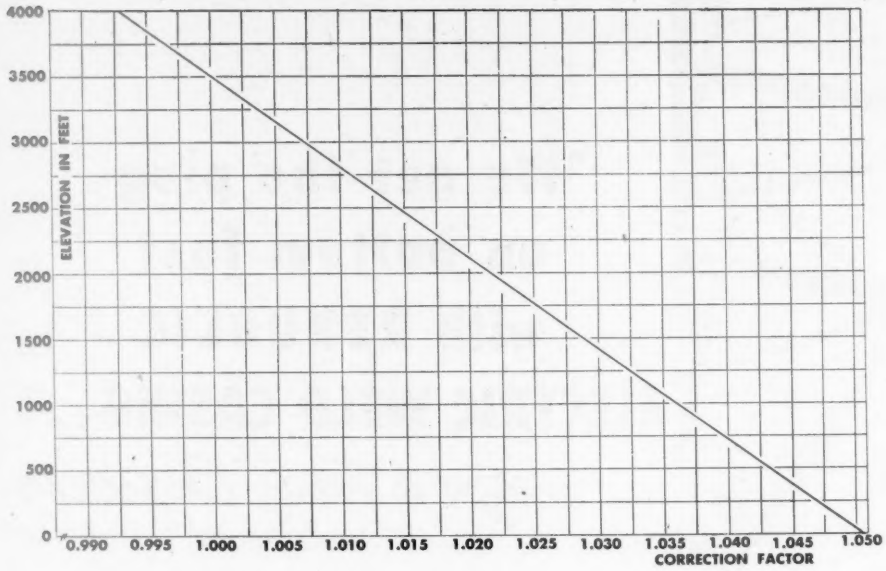
FIG. 2. Correction factor for elevation.



temperature, and air viscosity are constant as was assumed.

In order to simplify the original Darcy equation

Let:

$$R = Q/T \times \frac{P_2}{(P_1^2 - P_2^2)}$$

and

$$C = \frac{L}{A} \times 2000Z$$

then

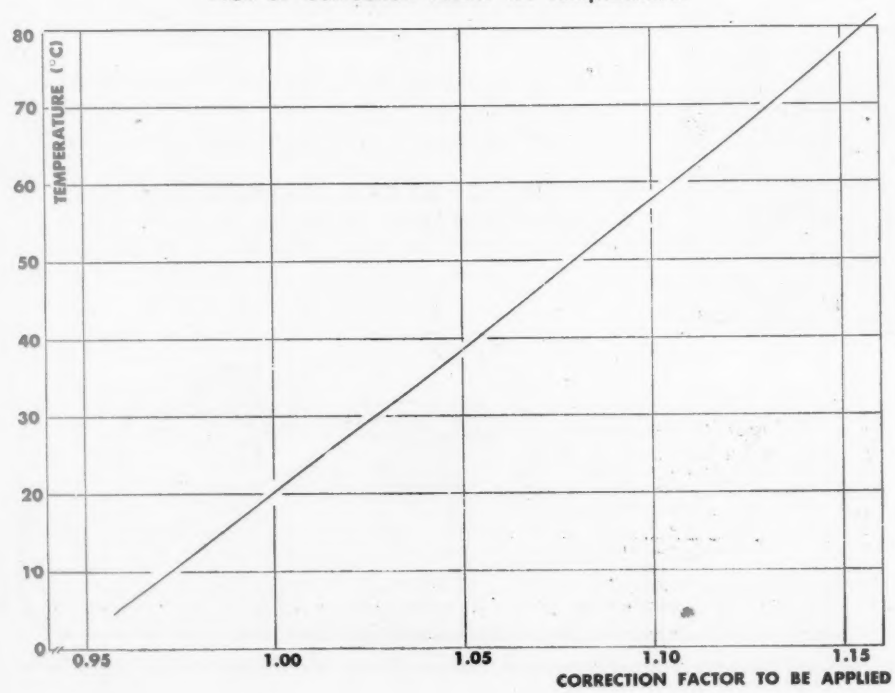
$$K = C \times R \text{ millidarcys} \quad . \quad . \quad (4)$$

This simplification, equation (4), of the original Darcy equation shows that, in order to construct a nomograph, K must be related to two independently variable factors "C" and "R".

Method of Construction

Eleven capillary orifice meters were calibrated and graphs of deflection in centimeters of water versus flow rate in cubic centimeters per second were prepared (5). Referring to Fig. 1, it can be seen that the values of Q/T vary from 0.01 to 1000 cm^3/Sec. In order to cover this range a large sheet of 6 × 6 cycle log-log graph paper was used. The eleven capillary scales were arranged so that the deflections in centimeters of water corresponded to the correct "Q/T" on the lower logarithmic scale.

FIG. 3. Correction factor for temperature.



Input pressure (P_1) ranging from 5 centimeters of mercury to 65 lb per sq in. gauge were chosen as the working pressures and the corresponding values of $\frac{P_2}{(P_1^2 - P_2^2)}$ were calculated for each pressure. The family of curves in Fig. 1 was obtained by plotting $Q/T \times \frac{P_2}{(P_1^2 - P_2^2)}$ versus Q/T for each pressure shown. The values of $Q/T \times \frac{P_2}{(P_1^2 - P_2^2)}$ (i.e. "R") are shown on the vertical scales. The factor $L/A \times 2000Z$ was then developed using a series of parallel logarithmic scales. The area term (A) is determined from the diameter of the core, which is taken as original data. The viscosity (Z) for dry air at 20 C is 0.0181 centipoises. The only two variables in the equation $C = \frac{L}{A} \times 2000Z$ are length (L) and diameter (D). By the appropriate choice of logarithmic scales "C" was set up as a function of L/A in the form of a straight line nomograph (7). It was necessary to use a C^1 scale in order to cover a greater range of length and diameter with minimum of error in reading scales. The C^1 scale is merely a compacted "C" scale. The final or permeability scale "K" was set up as a logarithmic scale one-half way between the "R" and "C" scales, in order to obtain the multiple R × C.

The units were chosen so that the "K" scale read directly in millidarcys.

Method of Using Nomograph

The input pressure in centimeters of mercury or psig, the length, the diameter, the deflection of the water manometer, and the number of the capillary used must be recorded. A strip of lucite with a fine straight line down the center facilitates reading the nomograph. The steps in using the nomograph are:

(1) Choose the required capillary number and then read horizontally to the recorded deflection of the water manometer. Placing the straight edge on this point go vertically to the recorded input pressure, turning about this point go horizontally to the right to get the "R" value from the vertical scale. Keep this point for further reference.

(2) The diameter and length of core are located on the "D" and "L" scales respectively and the two points are joined by a straight line to get the value "C".

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(3) Transfer the reading obtained from the "C" scale to the "C¹" scale and join this point to "R" obtained in step No. 1.

(4) The permeability is read directly in millidarcys from the "K" scale.

Elevation and Temperature Corrections

The nomograph shown in Fig. 1 was constructed for the average barometric pressure of Calgary, Alberta, Canada, namely 667 millimeters of mercury. In order that the nomograph could be used at other elevations a correction curve was drawn. The plot of elevation versus a multiplying factor is shown in Fig. 2. In order to obtain the curve in Fig. 2 a correction factor was calculated for each input pressure at each elevation. Since the maximum correction factor for any one elevation is less than 10 per cent and the minimum correction is 1 per cent for the same elevation, an average correction factor was used. The curve of Fig. 2 was obtained by plotting elevation versus the average correction factor, for all input pressures at that elevation.

Similarly a correction factor must be applied for any temperature other than 20 C. The plot of temperature versus a multiplying factor is shown in Fig. 3.

Sample Calculations of Permeabilty from Core Results

The following calculation will give a comparison of results obtained by direct calculation and then by the nomographic method of solution. The data are that recorded during an actual test run in the laboratory.

Original Data Recorded

Core length
= 9.40 cm.

Diameter of core
= 8.81 cm.

Capillary orifice used
= No. 1.

Input pressure
= 10.03 cm. of Hg

Deflection of water manometer
= Right hand side 3.37 cm.
Left hand side 3.30 cm.

Actual barometric pressure
= 68.30 cm. of Hg

Laboratory temperature
= 25 C.

Derived Data Required for Calculation of Permeability

Area of core $\frac{\pi}{4}D^2 = \frac{\pi}{4}$
$\times 8.81^2 = 61.0\ cm^2$

Length of core 9.40 cm.

$$\text{L/A factor} = \frac{9.40}{61.0} = 0.154 \text{ cm.}$$

Input pressure (P_1) = 10.03 cm. of

$$\text{Hg} = \frac{68.30 + 10.03}{76.0} = 1.03$$

atmospheres absolute

Total deflection of water manometer = 6.67

Output pressure (P_2) = $6.67 \times$

$$\frac{1}{13.6} \times \frac{1}{76.0} + \frac{\text{barometric pressure}}{76.0}$$

$= 0.007 + 0.899$

$= 0.906$ atmospheres absolute

Flow rate (Q/T) = 45 cm^3/sec. (from original calibration curve of capillary No. 1)

Temperature = 25 C

Viscosity of air = 0.0183 centipoises.

Computations

Equation (3) $K = \frac{Q}{T} \times \frac{L}{A} \times$

$$\frac{P_2}{(P_1^2 - P_2^2)} \times Z \times 2000 \text{ millidarcys}$$

$$= 45 \times 0.154 \times \frac{0.906}{(1.062 - 0.820)}$$

$\times 0.0183 \times 2000 = 949$ millidarcys

Referring to the nomograph, Fig. 1 —the dotted lines indicate sample calculation. Result by this method is K = 900 millidarcys.

The error obtained by using the nomograph is approximately 5 per cent. This error is due partly to the temperature being 25 C instead of 20 C and partly to the barometric pressure being 68.30 centimeters of mercury instead of the average 66.70 centimeters of mercury.

If a temperature correction were applied, the permeability would be:

K = 900 × the multiplying correction factor obtained from Fig. 3.

= 900 × 1.013 millidarcys.

= 912 millidarcys.

The percentage error would now be approximately 4 per cent.

Conclusions

The errors involved in using the nomograph rather than the tedious computations are less than the generally accepted 10 per cent allowable. A temperature correction need not be applied unless the operating temperature falls outside the range 10-30 C (6 per cent error). In operations at altitudes different from that used the K scale of the nomograph may be shifted in accordance with the factors given in Fig. 2.

Acknowledgments

The writer wishes to express his thanks to Imperial Oil Limited, for permission to publish this paper.

Acknowledgment is made for the assistance of J. W. Young, Research Engineer of the Imperial Oil Limited, Producing Department, Western Division, in setting up the basic scheme of the nomograph, and to T. H. Martin, Engineer-in-charge of the Petroleum Engineering Laboratory, for his assistance in editing this article.

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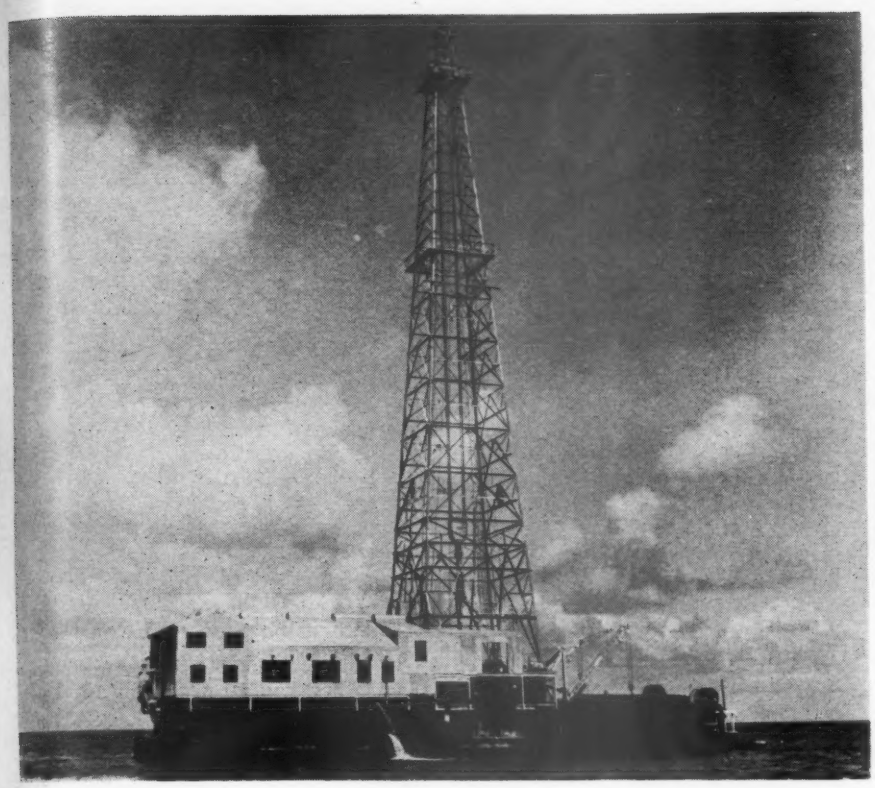


Drilling Barge Designed For 20,000-Ft Depths

Indicating a continuing and growing confidence in the prospects of finding more oil in the Louisiana coastal area below 12,000 ft, The Texas Company has put into service the latest and largest available equipment for deep well drilling. The company drilled the deepest well of 1948 in all of the Gulf Coast area by going to 16,106 ft in the Queen Bess Island area, Jefferson Parish, Louisiana. This was only 550 less than the record, made in 1944.

For the coming year the company has obtained the largest power rig afloat, designed for drilling 16,000 to 20,000 ft. It was recently rigged up at Montegut, 17 miles south of Houma, Louisiana, and put on a 13,000-ft test in the Houma District in Terrebonne Parish. By "largest" it is not intended to infer the largest barge or tallest derrick. Furthermore, barge-mounted rigs with more horsepower, one with equivalent size drawworks, and another with pumps that are said to be as large or larger are recognized. Nevertheless, when considered as a complete unit, the huge rig[1] is believed to make a new record in drilling capacity for floating rigs.

The drilling barge, known as "Barge Rhodes" is a "U" type. It is 170 ft long, 54 ft wide, and has a draft of 12 ft, and may be submerged in water up to 10 ft deep. The slot in the barge is 85 ft long and 10 ft wide. Fuel oil storage capacity of the barge is approximately 1400 bbl. Its mud pit capacity is about 1000 bbl with approximately 1700 bbl reserve capacity. The derrick substructure has a height of 17 ft 3 in. and there is a step-down of 5 ft 5¾ in. between drawworks and the No. 1 engine skid. There is a 10 ft substructure under the engine compound.

The derrick[2] is 189 ft high with 37-ft base and has a safe working capacity of 1,500,000 lb. The machinery consists of a drawworks[3] with all standard equipment, including an auxiliary brake, air-operated catheads, and micromatic feed-off control.[3] Four 500 hp supercharged diesel dual fuel engines[4] drive the rig components, making 2000 hp available for hoisting. Space is available to install larger engines, if greater power should be required. Four small diesels having a total of 560 hp drive mud mixing pump, an independent core reel, and the electric power plant. Emergency alarm devices were given special attention to assure safe operation of the rig.

A 4-engine fluid drive group[5] is used with controls for each engine, both at the driller's position and at each engine. This permits the driller to control the degree of slip to give optimum speed and power in meeting variable work requirements, and enables the engine man to use them as a disconnect clutch in an emergency.

The drive chain compound is so arranged that the No. 2 engine can be by-passed. If the No. 1 engine is down and No. 2 is driving the No. 2 pump, the No. 3 engine can be used to drive the drawworks without interfering with the No. 2 engine.

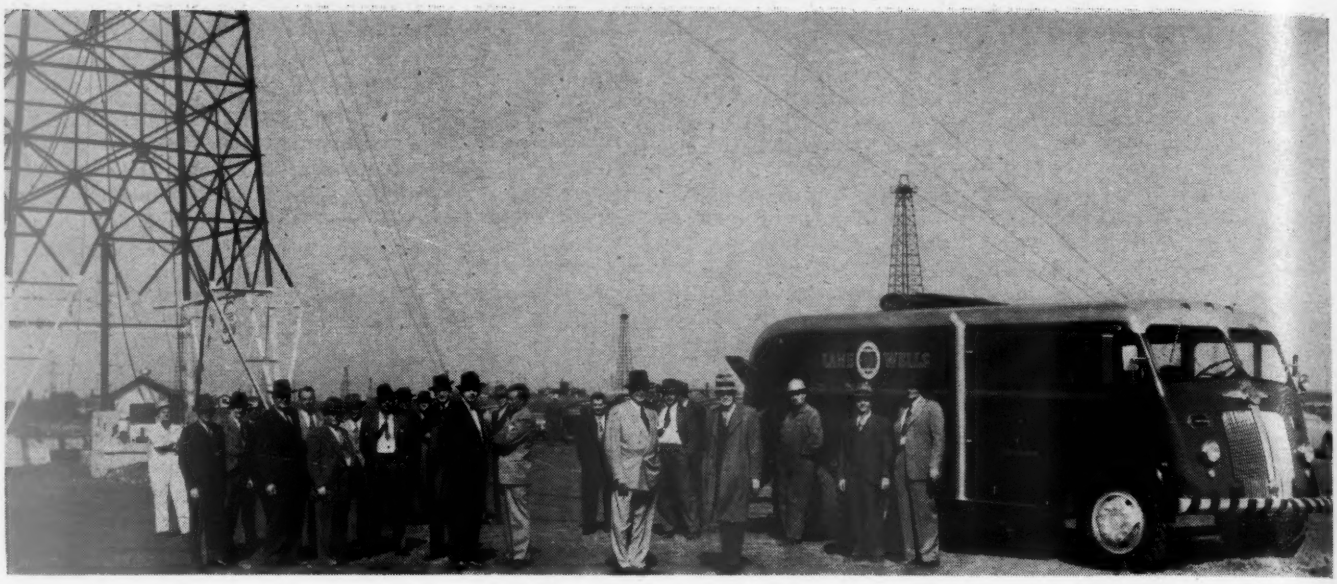
The main pumps consist of two 8½ by 16-in. power pumps. They are situated beneath the 4-engine compound and are chain driven from the compound through a 2-speed transmission. The fluid ends of the two drives are in line for convenience of suction manifold. These drives are from the No. 2 and No. 4 engine shaft extensions and are so arranged that any or all of the engines can drive either or both pumps. These pumps will also be used to discharge ballast in the barge by a series of jets when it is to be floated.

The rotary machine[6] is shaft driven from the drawworks, which avoids use of a rotary chain. Universal joints in the shaft drive allow the rotary to be moved 4 in. in any direction, thus providing for settling of the barge.

Electric equipment on the barge was given more than usual attention from the standpoint of safety. All electric motors and controls are explosion proof. Two vapor-proof explosion resistant light plants each have capacities of 75 kva at 60 cycles ac and 208 v. Explosion-proof motors drive two pumps for wash water and two deep-well turbine pumps for cooling water for the heat exchangers with which main rig engines are equipped. Motors for driving two air compressors, five 5-ton air hoists, two shale shakers, and five bug blowers that keep off mosquitos and cool the crew, are also explosion proof.

The barge has emergency living quarters for the crew and office facilities for the tool pusher. * * *

[1]The National Supply Company's second Ideal 160 Rig.
[2]Built by Lee C. Moore Corporation.
[3]Ideal Type 160 Consolidated Rig.
[4]Superior PTDS-6.
[5]Ideal.
[6]An Ideal SHS-20½.



Group gathers at renowned Mary Sudik No. 1 of Cities Service Company, which first roared in March 26, 1930.

25,000th Radioactivity Log Run —Famous Well Gets Honor

Standing: Earl Ives, assistant division superintendent, Cities Service Oil Company; Paul Strasbaugh, Oklahoma City Chamber of Commerce; Milo Margeneau, Cities Service director of public relations; G. E. Hendrickson, Cities Service Petroleum engineer; K. C. Sclater, *The Petroleum Engineer*, kneeling. Veteran well again makes history, as it did on its wild arrival 20 years ago.

THE oil well doctors took another look at wild Mary Sudik No. 1 March 24 to see if the discovery well of the Wilcox sand in the Oklahoma City field might have further profitable production from another zone.

Almost exactly 20 years after the Cities Service Company's Mary Sudik blew in the Lane-Wells Company ran its 25,000th radioactivity well log on the veteran well.

Wilcox sand zone in the field has produced nearly 500,000,000 bbl up to January 1, 1950. The Wilcox zone is still producing about 12,500 bbl a day from 420 wells.

The No. 1 Sudik well flowed its production until January, 1936, when it was placed on the pump. After pumping a short time the well was shut down until November, 1938, when it was utilized in the secondary recovery program in the south part of the Oklahoma City field. The well has produced nearly 800,000 bbl of oil.

The occasion indicated the steady growth in the acceptance of the radioactivity well logging service since it was introduced commercially in April, 1940, in the Polo field in northern Oklahoma. It is interesting to note that 15,000 radioactivity well logs have been run since October 24, 1947, when the 10,000th log was run.

The need for a method of obtaining more well information through casing spurred the development of radioactivity well logging, which was conceived in 1938 by Engineering Laboratories, Inc.

The knowledge that gamma ray radiation from rock formations could be converted into small electrical cur-

Earl Ives Christens Well Logging Equipment. First row: Wylie Pitchford, Cities Service farm boss; Earl Ives, William Green, president, Well Surveys, Inc.; M. J. Kirwan, Cities Service manager of production; Rodney Durkee, president, Lane-Wells Company; R. B. "Ike" Downing, Mid-Continent division manager, Lane-Wells. Second row: Jim Hughes, Lane-Wells sales manager; Henry Cortes, Magnolia Petroleum; Val Forsyth, Lane-Wells assistant chief engineer.

rents led to intense research and development to solve the problems of creating instruments to measure these currents. These currents, which measure about one ten-trillionth of an ampere, are utilized in a technique that provides the oil operator with a continuous graphic curve that reveals subsurface rock formations in either open or cased holes. The curve so developed is known as the Gamma Ray curve.

The first commercial job in April, 1940, was done by Well Surveys, Inc., a separate concern set up by Engineering Laboratories, Inc. In June, 1940, Lane-Wells was licensed to offer the service throughout the United States and Canada. Through subsidiary organizations the service is now available in Canada and Venezuela.

The Neutron curve, introduced in 1941 to provide additional information, has been accepted as a vital part of logging technique. The Neutron curve actually is the result of a lot of gamma rays generated while the well bore is being exposed to a Neutron bombardment. These secondary gamma rays, several times greater in magnitude than the natural rays emitted from the formation, indicate the presence or lack of fluid in that formation.

The Neutron curve, therefore, is by itself an indirect indicator of relative porosities. A new analytical technique currently under development by Lane-Wells and WSI makes it possible to interpret the Neutron curve in terms of actual porosity. Porosity determinations made by this method from curves taken in open and cased holes agree almost exactly with porosities of formation cores determined in the laboratory.

Used together these two curves present a complete log, a valuable means available to the industry for obtaining geological information through casing. These two curves are used in a variety of applications such as obtaining a complete record of the formations where mechanical difficulties and contaminated drilling muds prevent other types of logging. The curves detect fluid bearing zones, dry gas zones, casing seats, liner overlaps, formation tops and thicknesses, distribution and travel of radioactivated cement and are used extensively in resolving differences in depth measurements on new wells.

The feature that makes the curves so useful in measurement problems is the collar log. An electrical collar locator is built into the gamma ray instrument in such a manner that the position of each casing collar is recorded on the chart at the same time the formation is being logged. The gamma ray curve with the imposed collar log provides a permanent record of the fixed relationship of casing collars to formations which is extremely helpful in planning any well operation anywhere in the well at any time in the future.

Rodney S. Durkee, president, Lane-Wells, Los Angeles and William Green, president, Well Surveys, Inc. and other officials with the companies and Cities Service witnessed the event. In the afternoon the officials and other guests traveled to Tulsa, Oklahoma to attend a reception given by Lane-Wells and Well Surveys, Inc. at the Tulsa Club.

* * *

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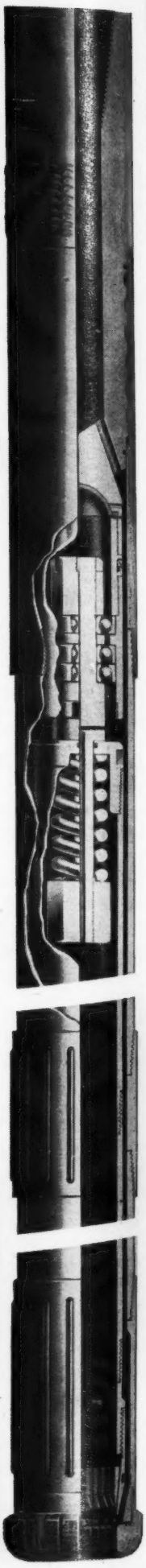

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NEWS

Scurry County Operators Form Engineering Committee

Over 75 operators in the Scurry County, Texas, oil fields are cooperating under the temporary chairmanship of D. V. Carter in the formation of an Engineering Committee, William L. Horner, chairman of the organizational committee announced. These operators are combining information to serve their needs in obtaining basic engineering information. The information is needed to determine the proper methods for operating the wells, for the development and application of modern engineering methods, and to evaluate pressure maintenance so as to prevent waste, promote conservation, and increase the ultimate recovery of oil.

The organization committee has been furnished 50 copies of the bulletin of the Interstate Oil Compact Committee "Organization and Functioning of Oil-Field Engineering Committees", which was prepared by William M. McQueen of Alabama, Leland Richardson of Louisiana, and Robert E. Hardwicke of Texas.

Colon Venezuelan Production Is Lowered in February

The Colon Development Company Ltd. produced 332,115 bbl of crude oil in Venezuela for the four weeks ending February 27, 1950. This amount is less than the 344,712 bbl produced by this company during the four weeks ending January 30.

New Test Method Raises Output at Delhi Well

A new test method is raising output in the Delhi Oil Corporation No. 1 Giomi well in the Blanco gas field of the San Juan Basin of New Mexico, company officials have reported. A spokesman for Delhi said the Giomi test, had tested a potential of 21,500,000 cu ft of gas daily as compared to other wells ranging from 1,000,000 to around 12,000,000. He stated that the "strategic placement" of the charges was credited with making the well an improvement over other wells in the field. The well was shot in the Point Lookout, topped at 4723 ft, with 700 quarts of nitro.

1949 Termed Outstanding Year For Socony-Vacuum Company

Major discoveries in West Texas and Southeast New Mexico enabled the Socony-Vacuum Oil Company, Inc., to attain in 1949 an outstanding year in finding crude oil in the United States, company officials have announced. Only one other year in the company's history remotely compares with 1949 in volume of oil found.

The company's domestic reserves of crude oil and condensates at the year's end are estimated at one billion 380 million barrels compared with one billion 194 million at the end of 1948. A major discovery was the Pegasus field in Upton County while several thousand acres of productive leases in Scurry County also appear promising. In the Bough field, Lea County, New Mexico, the company brought in three wells of large potential at 9600 ft.

Nettleton to Attend Third World Petroleum Congress

L. L. Nettleton, of Houston, Texas, will represent the Society of Exploration Geophysicists at the forthcoming Third World Petroleum Congress, it has been announced by Andrew Gilmour, president of the national society. The Congress will be held at The Hague, May 28 to June 6, 1951. The international meeting was last held in Paris in 1937.

Nettleton will serve as the Society of Exploration Geophysicists' member for the National Committee for the United States. All geophysical papers submitted for the Congress should be sent to him at 1348 Mellie Esperson Building, Houston 2, Texas.

Dallas API Office Moves

The Dallas office of the division of production of the American Petroleum Institute has moved to 816 Rio Grande National Building, Dallas 2, Texas. There is no change in local or long distance telephone numbers for the Dallas office, C. A. Young, director, announced.

Saudi Arabian Production

Crude oil production in Saudi Arabia during February amounted to 13,900,285 bbl, or an average of 496,439 bbl per calendar day, it was announced today by the Arabian American Oil Company, compared to 13,947,930 bbl produced in January.

Crude oil production for the first two months of 1950 amounted to 27,848,215 bbl, an average of 472,004 bbl per calendar day.

New officers for Dallas-Fort Worth Nomads. L to R: Courtney J. Berlin, Baker Oil Tools, secretary; E. F. Shiels, International Derrick and Equipment, assistant secretary; E. J. Whetzle, *Drilling*, treasurer; J. Lewis Foster, Foster Cathead, membership committeeman for the Wichita Falls area; A. J. Olson, Continental Supply, president; J. M. Bridges, Buda Engine and Equipment, deputy sergeant-at-arms; John A. Hall, Weatherford Oil Tool, membership committeeman for Weatherford area; Brad Mills, AAODC, regent; J. E. Everroad, Mid-Continent Cummins Export Corporation, sergeant-at-arms and chairman entertainment committee; and R. E. Todd, Core Laboratories, Inc., assistant treasurer. Not shown are: K. W. Davis, Mid-Continent Supply, vice president and chairman of initiation and ritual committee; J. C. Baseheart, Buda, regent; J. A. Mussler, Continental Supply, chairman of the membership committee; H. C. Otis, Otis Pressure Control, chairman auditing committee; K. Marshall Fagin, *The Petroleum Engineer*, chairman welcoming committee; S. W. Webster, Emsco Derrick and Equipment, and Victor LeMay, Mid-Continent Supply, official photographers.

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Drilling Problems on Santa Rosa Island

Members of the American Institute of Mining and Metallurgical Engineers Juniors, Pacific Petroleum Chapter, gathered at the Rio Hondo Country Club, Downey, California, recently to hear a discussion on "Operation Santa Rosa Island." Ernest O. Kartinen was the speaker.

Kartinen, who is in charge of the construction and maintenance department of the Signal Oil and Gas Company, was responsible for the engineering and planning that was necessary to transport a complete drilling rig and camp from the California mainland to Santa Rosa Island. Colored motion pictures, which were taken by the speaker, were used to illustrate the methods used to move the equipment, both on land and water.

In June, 1948, Signal Oil, as operators, Honolulu Oil Corporation and Macco Construction Company undertook the drilling of three wildcat wells on Santa Rosa Island. This island is the second largest of four that form the Santa Barbara Islands. It is about 20 miles long and 8 miles wide. It is mountainous with its highest point about 1600 ft above sea level. There were numerous springs in the canyons, which in normal times supplied water for the cattle, but in 1948 everything was dry, and the chances of developing water from this source for drilling purposes looked very discouraging. Standard Oil Company had drilled a well on this same island in 1932 and there was a wooden pier and a resemblance of a road part way across the island. Upon inspection the pier proved to be adequate to handle only relatively light loads. The only roads were so-called jeep trails, which could be traveled only by short wheel base four-wheel drive Army equipment. The three drilling sites were on the western end of the island.

The first month was spent in field work and gathering data on the entire venture. The problems of transportation of heavy equipment, everyday supplies and personnel, were the most important. Every operation depended in some way on transportation. Construction of some 18 miles of road, development of a suitable water supply for drilling, and the construction and maintenance of a camp capable of handling at least 50 men were necessary. These were the important problems for which answers had to be found.

After a careful study of the terrain, by both aerial and surface reconnaisance trips, it was decided to use the existing road for a distance of 5½ miles. This road followed a ridge up to the top of the island's highest peak, some 1600 ft above sea level. From this peak went another ridge, which was followed with a road or 5½ miles to the first location. This original road went past an abandoned Army camp, which had housed a radar crew during the war. Some of the buildings were still there minus doors and windows, floors, light fixtures, etc. Receiving permission to use this

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camp, the entire operation then was planned to conform with landing operations conducted through Beecher's Bay, and using the Army camp for headquarters.

The drilling equipment was far the greater part conventional, most of it portable and skid mounted. The principal item was the drilling rig, a portable, trailer mounted unit having a 96 ft telescopic quick-lift mast. Mounted on a 30-ton trailer, the rig consisted of a torque converter equipped, air-controlled hoist, powered by a 300 hp twin diesel engine. The weight of this unit was approximately 45 tons. The rated depth was 6500 ft, using 4½-in. drill pipe. The mud pump was a 7¼ by 12-in. unit, powered by a torque converter equipped twin diesel engine. The weight of the pump unit was 28 tons. Accompanying this equipment was the usual complement of tools, drill pipe, casing, cement, mud, and other supplies. The total weight of the drilling equipment was in excess of 300 tons.

The land transportation problems were solved by the use of three jeeps, two pickups, one war surplus Burma jeep, one war surplus 2½-ton flatbed truck, one RD-7 bulldozer, one RD-8 bulldozer, and a miscellaneous assortment of two and three axle trailers and semi-trailers. The heavy equipment was moved overland by tractors pulling the trailers. Bulldozers were used for road construction, well sites, sump construction, and moving.

Much has been said about the wartime landing crafts and beach-head operations and therefore the possibilities of using some of the various types of landing craft on this job were investigated. They all proved either inadequate for the job or were too costly. After some consideration it was decided to use ordinary flat wooden barges. These barges are 133 ft long, 42 ft wide, and 14 ft high. They were being used on the Long Beach breakwater to haul as high as 900 tons of rock at a time. They hauled about 100 tons per foot of submergence.

As to time schedule, the island on June 26 was first looked over. August 17 the first load of big equipment was landed. October 5 the drilling equipment was landed, and on March 11 the crew moved off, having in the meantime built 18 miles of road, laid 30,000 feet of pipe line, maintained a camp for 50 men, which was several times filled to capacity, gone through as cold a winter as was remembered on the island, had snow, which was last recorded some 400 years previously by Cabrille on his log. Sixteen barge trips were made to and from the island.

Geophysicists Accept New Affiliate Student Society

The Society of Exploration Geophysicists has accepted a new affiliate student society at St. Louis University. The formal acceptance brings to three the number of student societies. The addition highlights the recent rapid growth of the society, which has during the last three years formed local sections in Tulsa, Oklahoma; Dallas, Midland, Houston, and Fort Worth, Texas; Shreveport, Louisiana, and Los Angeles, California. Other sections are presently organizing in Calgary, Canada; San Antonio, Texas, and Denver, Colorado. Plans for a European section are being made.

The St. Louis University Society will have V. J. Blum, S. J., as faculty sponsor. The university claims the first geophysical department in the western hemisphere, since it was organized in 1925 by James B. Macelwane, S. J., now dean. Other student societies are at the University of Tulsa and Colorado School of Mines.

The new student society has elected Warren E. Daniels, president; James H. Stelloh, vice president; James B. Hummert, secretary; and Fred Bender, treasurer.

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Foreign Visitors. Jack Stovall of Drillexco, Turkey, and Jack Lawson of Dominion Oil Field Supply, Edmonton, Canada, foreign visitors at a meeting of Dallas-Fort Worth Nomads are shown with A. J. Olson, chapter president.

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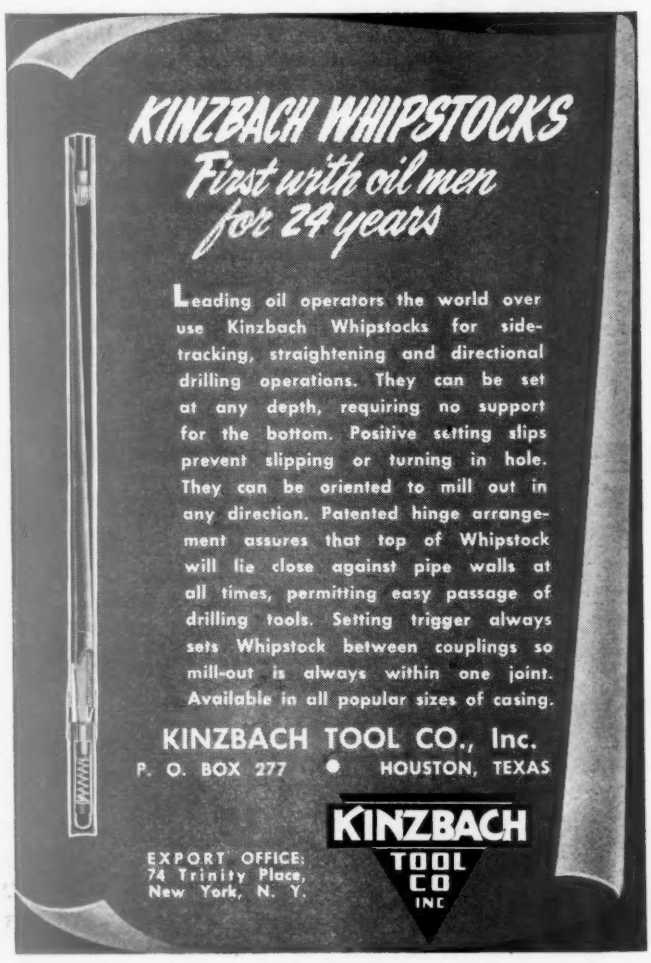
Glass, as a carrier of jet charges, is revolutionizing jet perforating! A glass jet perforator,* is bringing in production and substantially increasing production in oil wells where other methods had failed to get results! Glass jets were recently introduced, after 15,000 had been shot in oil wells—without a single gun sticking, without a carrot or any debris being left in the well. In many instances, wells have been successfully re-perforated.

The introduction of glass as a carrier for jet charges is the result of many years of research. Some benefits of the glass jet include: Ability to use double the normal amount of explosives; no carrot or slug left to plug the holes, etc.

*Designed and made by McCullough Tool Company.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Los Angeles AAODC Open Meeting Held

The Los Angeles chapter of the American Association of Oilwell Drilling Contractors, under the chairmanship of W. W. "Bill" Cline, San Joaquin Drilling Company, held open meeting at the Petroleum Club in Los Angeles. It was the first application of a new arrangement under which pertinent segments of the oil industry will be invited to attend alternate open meetings. This particular gathering was open to equipment and supply.

John Grant, president of Loffland Brothers, was called upon first by Chairman Cline to report on certain pending state safety regulations affecting the drilling contractors. He did so, exhorting the Association to exercise continuous watchfulness over such matters to make sure that at least they are based in sanity. The chairman announced that he would appoint a representative from AAODC to sit in on the hearings at which these regulations are being discussed.

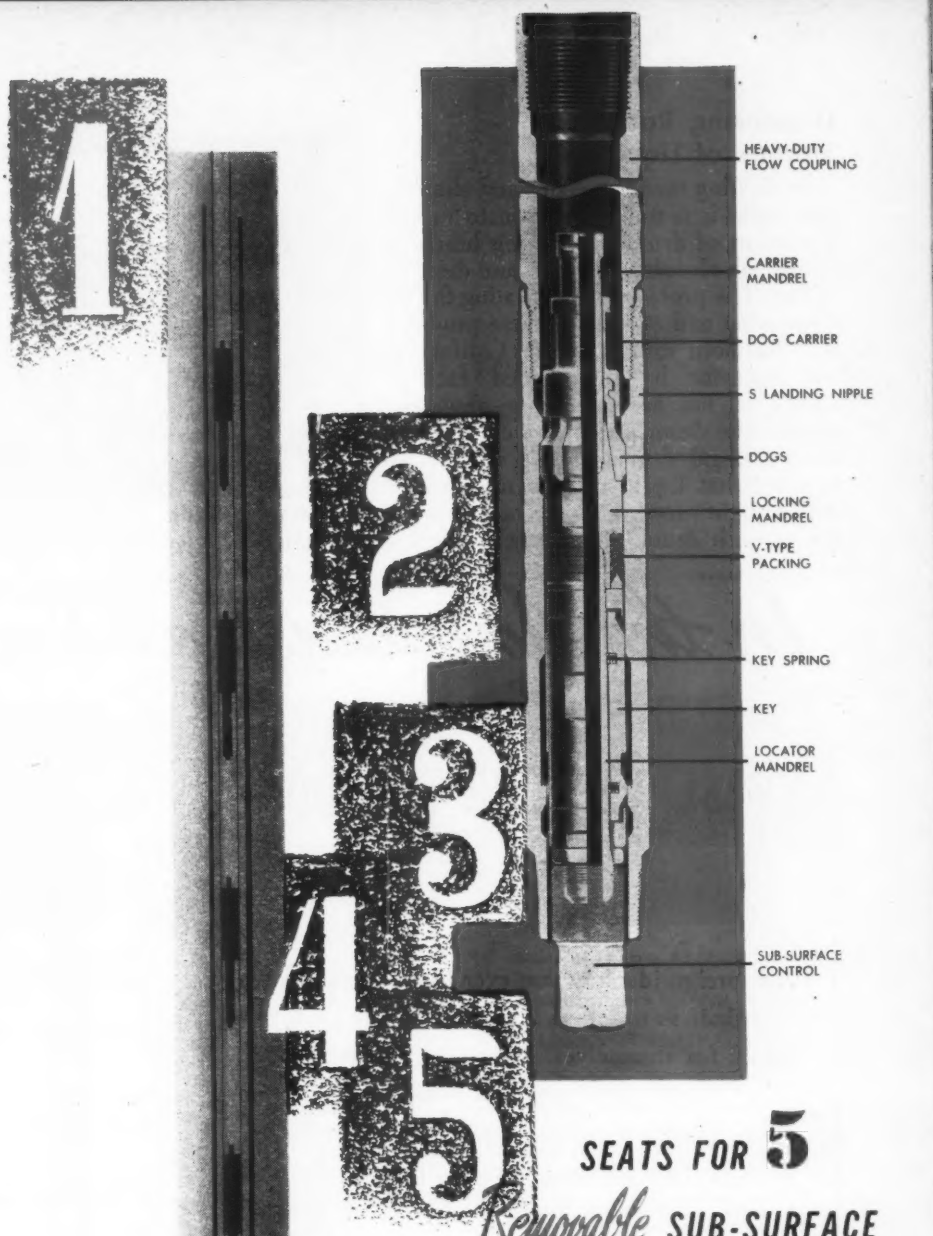
Bob Rose of Drillex then announced that the next open meeting would be held in May, at which time the chapter would play host to the oil operators. Speaker on that occasion will be L. A. "Doc" Cranston, president of Oil Producers Agency, and his topic will be "Oil Conservation." The business agenda was concluded with a short report from Harvey Davis, Crown Drilling Company, northern division chairman. Jan Law, consultant to the Long Beach Harbor Board, was speaker.

Law spoke on subsidence in the Long Beach field, a matter of great interest to operators all over the United States. He analyzed the causes of shift and shear; gave an estimate of the damage to the wells; and an account of what steps have been, and are being taken to remedy the situation and minimize future losses.

Lion Drills 72 Wells In 1949

During 1949, Lion Oil Company drilled the equivalent of 72 net wells of which 61 were completed as oil wells, one was a gas well, and 10 were dry holes. These wells were drilled in Arkansas, Louisiana, Texas, Kansas, Colorado, Wyoming, and New Mexico.

The company's annual report pointed out that the most spectacular development program in the history of the company began with the discovery of the Diamond M field of Scurry County, Texas. In this prolific reef pay Lion completed 52 wells during 1949. Spacing pattern in the Canyon Reef formation is one well to each 40 acres and indications are that most of the company's block of about 5600 acres will be productive.



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Dispensing Rack Aids Storage of Liquids

In drilling medium depth and shallow wells, it is not uncommon to use a number of drums containing lubricating oil, cleaning solvents, and diesel fuel. The problem of facilitating the dispensing and storage of these products has been solved for one California operator by the welded rack shown in the accompanying photograph. The drum rack has a capacity of six 55-gal drums and is so constructed that liquid can be removed with a slight pressure on the rack handle of each drum. The frame of the rack is made from I-beams and short sections of drill pipe with the uprights constructed of line pipe. Two hoisting eyes are welded in place along the top horizontal bar for easy portability. The cradle for each barrel is made from light weight strap iron and hinged to the "V" shaped angle iron uprights with a short length steel pin. This pin is welded to the cradle uprights and freely turns in a short section of pipe welded to the top of the angle iron. One side of the cradle bracing extends a few inches over the top of the barrel, and acts as a convenient handle for pouring the liquid. A short length of chain attached to the cradle in the center goes around the back of the drum and fastens it securely in the rack. As the drums are emptied, they tilt forward thus avoiding spilling while in operation.

Dispensing Rack. Dispensing rack that holds a number of drums containing lubricating oil, cleaning solvents, and diesel fuel.

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B. of M. Covers Oil Field Waste

The Bureau of Mines, U. S. Department of the Interior, has published in booklet form, Technical Paper 715, A Method of Resolving Oil-Field-Waste Emulsions, by J. W. Horne and J. Wade Watkins. The 46-page booklet is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $.50. It contains numerous charts, illustrations, and pictures, which add to the clarity of the book.

IPC Abandons Syrian Concession

Syrian Petroleum Company is expected to relinquish exploration rights in the second zone of its three-zone concession in June. The company, a subsidiary of Iraq Petroleum Company, was granted Syrian Oil exploratory rights in 1934 when the country was under French mandate.

Several test wells were dug by the company, especially in east and northeast Syria. Rigs are still up at Ghouna and Djbeseh, in Dejerzireh, but the test wells have not produced oil.

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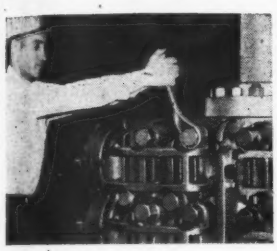
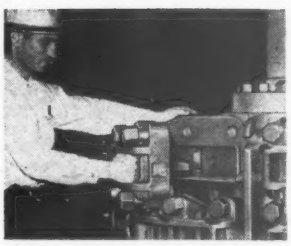
sets a new high in speed and simplicity in changing rams.

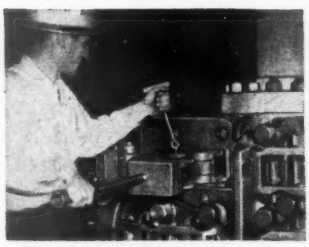
Here's all you do:



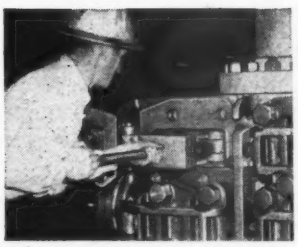
1. Unbolt Two Doors in the side of the Gate. You don't even have to remove the bolts –they remain in the doors where they can't become lost.



2. Swing the Doors Open and pull out the ram assembly. There's nothing to loosen, unlock or disengage. It slides right out.



3. Lift the Rams from the Gate and simply replace the Ram Blocks and rubbers with others of the desired size and type.

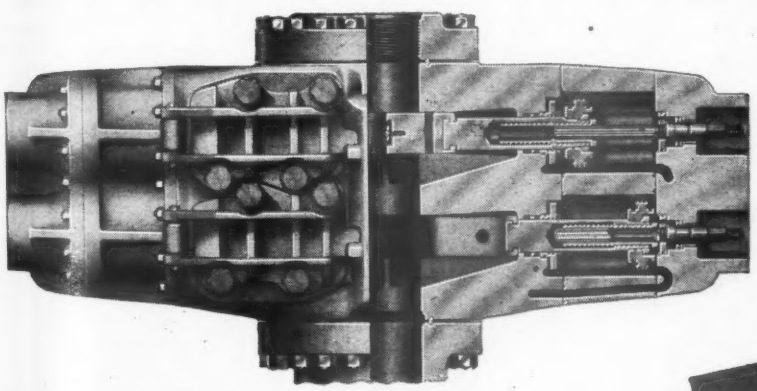


4. Slide the Ram Assembly back into the Gate, close and bolt the doors. Closing the doors automatically aligns Ram Assemblies within Gate.

It's as simple as that—and as fast. And here's another important feature—you can make a complete ram change *whether the pipe is in or out of the hole!*

Best of all the unusual speed and simplicity with which rams can be changed is only one of *many* vitally important advantages that Shaffer engineers—pioneers in the development of high pressure control equipment—have incorporated into the Shaffer Hydraulic Cellar Control Gate. A few of the many other features are outlined at right. But be sure to get the *complete* story before you buy *any* cellar control gate equipment. No other equipment provides so much protection—in such a compact space—with so many operating advancements as . . .

The SHAFFER HYDRAULIC CELLAR CONTROL GATE!



The sectional view above shows how *two* separate ram compartments are unitized into one compact body. Note the self-draining bottoms of the ram compartments . . . the direct hydraulic drive . . . and the completely enclosed design of the Shaffer Hydraulic Cellar Control Gate!

Write for the new Shaffer 1950 Catalog that gives full details on the Shaffer Hydraulic Cellar Control Gate as well as on other Shaffer products!

See pages 4433 to 4496 of the 1950 Composite Catalog.

Additional unique features in the Shaffer Hydraulic Cellar Control Gate

- **SPACE SAVING COMPACTNESS:** *Two* separate ram compartments are unitized into one body, yet the *overall* height of the entire Gate, including *both* compartments is *only 30"* even in sizes as large as 13⅜". Smaller sizes even less!
- **COMPLETELY ENCLOSED DESIGN:** All moving parts, including piston rod ram shafts, are completely enclosed within the body of the Gate. No moving parts project from the Gate—nothing to become damaged or wedged by falling objects or loose timbers in the cellar, nothing to become corroded by salt fluids or chemical muds dripping into the cellar. This means greater safety, less maintenance!
- **DIRECT HYDRAULIC DRIVE:** Hydraulic operating cylinders are *directly behind* the rams for direct action, maximum simplicity, greatest safety. No secondary connections between hydraulic cylinders and rams!
- **SELF-DRAINING BODY:** The rams travel on high narrow guide ribs raised above the steeply-sloped bottoms of the ram compartments. Mud and sand quickly drain back into the well—no detrimental accumulations to interfere with free operation of the rams!

These and still other unique features make the Shaffer Hydraulic Cellar Control Gate the outstanding *hydraulic* gate available today. Get full details from your Shaffer representative—or write direct!

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CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

WHAT'S DOING IN DRILLING

Shell Sets Louisiana Production Depth Record

Shell Oil Company's No. 1 Weeks, Unit 2, some 12 miles from New Iberia, in Iberia Parish, Southern Louisiana, has set a new production record for that state. At 14,226 to 14,241 ft it tested to produce 540 bbl of oil a day, setting a new depth production record for the state.

Carter Completes Dual Test

The Carter Oil Company has completed a dual test of the Chimney Hill section of the Hunton lime and the First, Second, and Third Bromide sands at its No. 1 V. H. Cherry in Garvin County, Oklahoma.

The well is flowing through tubing on test and flowed 560 bbl of 46 gravity crude oil in 11 hours, without any water, through a ¾-in. choke. Casing is perforated opposite the four horizons mentioned with total depth 10,177, plugged back from 10,180 ft.

The well previously had flowed 441 bbl in 12 hr and then flowed 129 bbl in 4 hr after which it ran into a fishing job.

Gulf Well Flows 570 Bbl a Day

Gulf Oil Corporation's No. 2 Foster in Okfuskee County, Oklahoma, flowed at a rate of 570 bbl of oil a day through a ¾-in. choke when it tanked 95 bbl of oil, without any water, on a four hours' test. With the oil was 181,000 cu ft of gas a day for a gas-oil ratio of 318 to 1. Total depth is 3549 ft.

Kansas Well Flows at Rate Of 11,000 Bbl per Day

Barbara Oil Company's No. 3 Page Estate, Barber County, Kansas, is reported to have flowed at a rate of 11,000 bbl of 28 gravity oil a day on a brief test, after having blown in and flowed wild for a time. Situated in the Rhodes pool, opened several months ago by the Barbara company, it was drilled to around 4400 ft, and preparing to wash into completion when it blew in. Oil went over the top of derrick, according to reports, before the control head could be closed.

After the flow was stopped and the well was under control, the control head was opened, and the well then flowed at a rate of 11,000 bbl a day.

Drilling Contractors Meet. A joint meeting of American Association of Oil Well Drilling Contractors Research and Education and Rotary Drilling Equipment Committees was held in Dallas recently to discuss standardization of drill collars.

Shown below are, standing, left to right: Brad Mills, AAODC, Dallas; Wm. F. Schmeling, Spang Chalfant, Fort Worth; Howard Texter, Spang Chalfant, and F. G. McClintock, The Zephyr Corporation, Tulsa; D. C. Neely, Spang Chalfant, Houston; Frank L. Thompson, Thompson-Carr, Inc., Midland, Texas; C. C. Brush, Spang Chalfant, Houston. Seated, back row: C. W. Alcorn, Falcon Seaboard Drilling, and A. W. Thompson, Thompson-Carr, Inc., Houston; B. R. Schabarum, Carl B. King Drilling, Midland; E. E. Rubac, American Iron and Machine Works, Oklahoma City; U. M. Stewart, Farley Machine, Hays, Kansas. Seated, left to right, front to back: L. E. Garfield, Hughes Tool, Houston; B. B. Groenewald, Exploration Drilling, Tulsa; E. R. Woodmamsee, Hughes Tool, Houston; J. C. Jennings, Jennings Drilling, Wichita Falls, Texas; W. F. Behrhorst, American Iron and Machine Works, Fort Worth; Kye Trout, AAODC, Dallas; Edwin Ross, Baash-Ross Tool, and J. B. Hughes, Hydril Company, Houston; Lloyd E. Tracy and F. M. Maier, Oil Well Supply, Dallas; W. L. Childs, Jr., W. E. Scarborough, and Wiley B. Noble, Reed Roller Bit, Houston; and V. S. Harlin, AI&M Works, Oklahoma City.

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High temperatures and pressures are a real threat to oil-well cementing jobs, and therefore endanger your investment in wells, tools and equipment. That's why it pays to use easy-pumping, hard-setting Unaflo Oil-Well Cement. Unaflo protects your investment these 3 ways:

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2. Unaflo also has *sustained* fluidity because of its delayed, post-poned, *retarded* set, which allows ample time, even during emergencies, to get cement in place.

3. After retardation, a heavy slurry of Unaflo hardens normally to form a denser, more impermeable seal.

To be sure... always protect *your* investment with Unaflo!

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Rotary rigs operating in oil fields of the United States and Canada*

March Weeks	Total	Gulf Coast	Pacific Coast	Oklahoma, Kansas	Arkansas, Louisiana, Texas	Illinois	Rocky Mountain, Canada	New Mexico, West Texas
1st.....	2042	475	134	365	147	70	144	707
2nd.....	2038	491	126	377	131	81	134	698
3rd.....	2009	483	121	377	128	76	143	686
4th.....	2035	507	135	369	116	83	125	700

* Figures released by American Association of Oilwell Drilling Contractors, as reported to them from Hughes Tool Co.

Midland County Well Is Ellenburger Discovery

General American Oil Company, Dallas, Texas, has completed its No. 1-E Peck, as an Ellenburger oil discovery four miles west of the Pegasus Ellenburger pool, in southern Midland County, Texas.

Flowing 53 gravity oil, the well flowed 1056 bbl in 24 hr. Pay is from 13,128 to 13,245 ft, which has been acidized with 1000 gal.

Mississippi Well Completed

Danciger Oil and Refining Company's No. 2 G. W. Armstrong in Wilkinson County, Mississippi, has been completed for an initial production of 36 bbl oil plus 625 MCF per 24 hr through 16/64-in. choke. Total depth of the well, which is in Possum Corner field, is 8307 ft. It is producing from the Wilcox sand.

Two Permits Are Granted For Drilling in Georgia

Georgia State Oil and Gas Commission has granted permits for the drilling of two oil wells, one by H. L. Chapman, Havana, Florida, and one by L. D. Cain, Houston, Texas. Chapman will drill an exploratory well in Decatur County, and Cain will drill his second exploratory well in Heard County. A third exploratory well is now being drilled by Mont Warren in Seminole County.

Drilling to Begin In Sahara Desert

Spanish engineers are about to begin exploratory drilling in the Sahara Desert. Prospecting rights have been granted a concern headed by Victor Felgueroso, in an area of some 25,000 acres in the Aalun district of Spanish Mauretania, Indoemaciones of Madrid has stated. The Spanish agreement requires that exploration begin within six months and end, if no strike has been made, within two years.

Glenrock Field May Get First Commercial Producer

Phillips Petroleum Company's No. 1-A may turn out to be the first oil well in Wyoming's Glenrock field with a heavy enough flow to be classified a commercial producer. The well was tested at 5817-5889 ft and recovered gas in three minutes and 100 ft of heavy oil and gas-cut mud, officals of the company stated. The well is a southerly extension to the discovery in the Glenrock field in Converse County.

Gulf Well Is Producing From Davis Sand Zone

Gulf Refining Company has opened gas-condensate production in the Davis sand zone in the Athens field of Claiborne Parish, Louisiana at its No. 1 Kinnebrew. The No. 1 Kinnebrew perforated casing at 8148-86 and 8208-33 ft, gauged 257 bbl of 52-degree gravity condensate and 2,954,000 cu ft of gas a day through a 20/64-in. choke.

Denton Field Gets Its Second Well

The No. 1 L. R. Chamberlain has been completed by Gulf Oil Corporation as the second producer from the Devonian in the Denton field in Lea County, New Mexico. The well reported a 24-hr potential of 1092 bbl through ¾-in. choke. Gas-oil ratio was 889 to 1. Production was natural from open hole between 11,501-13 ft.

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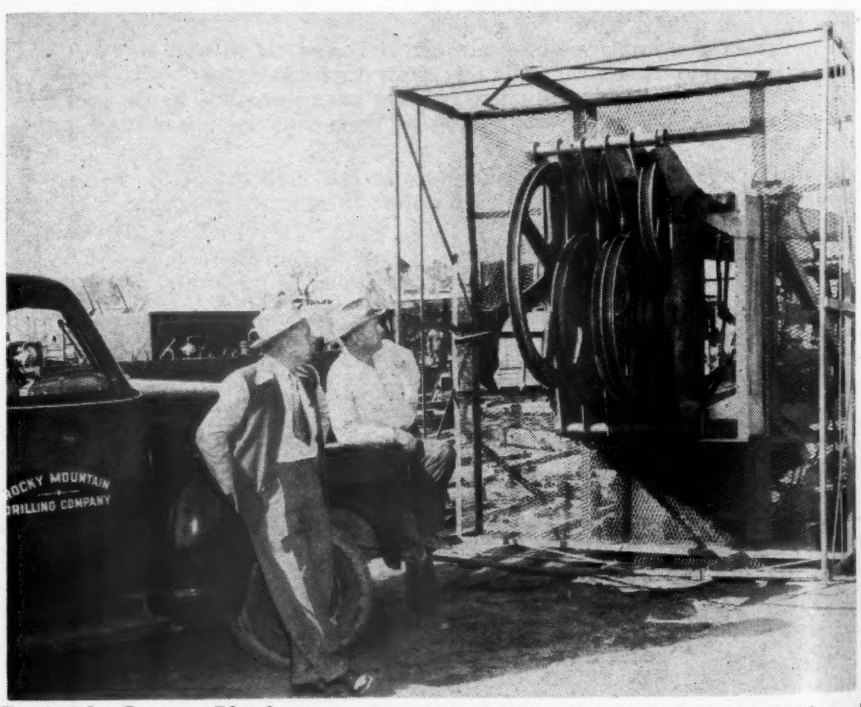
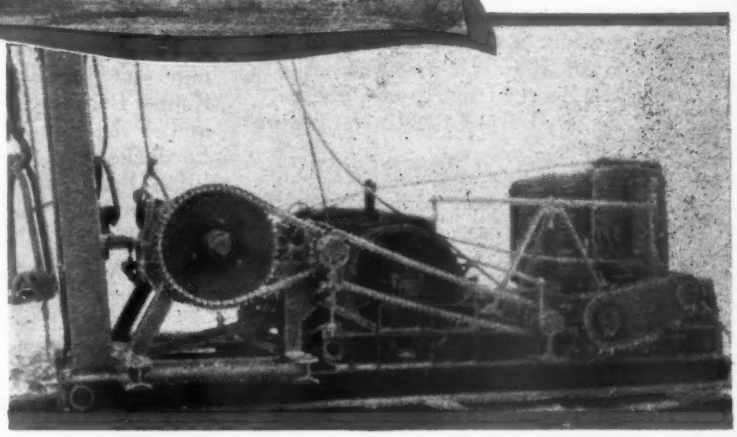


Portable Crown Block. Rocky Mountain Drilling Company's Bakersfield yard superintendent, S. O. Hollingsworth and J. W. Thatch, manager of the Bakersfield division of Regan Forge and Engineering Company, inspect one of eight recently installed Regan portable crown blocks. The installation is a part of Rocky Mountain's unitizing program.

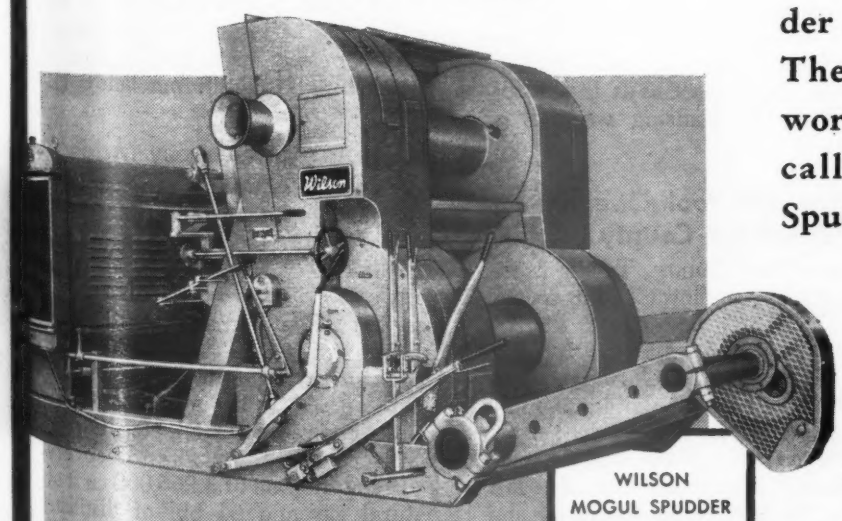
REMEMBER . . . . . .

THAT BARBED WIRE FENCE BETWEEN AMARILLO AND THE NORTH POLE?

One strand of the fence was down most of the time. You laid a shingle against the North wall of the Doghouse in November. When the shingle fell, it was Spring. And Borger was so hot the Rangers had to clean it up!



BUT Wilson WAS THERE!
AND WILSON WAS FIRST!



WILSON MOGUL SPUDDER

Above: An early WILSON Spudder at Borger, after a sleet storm. Then, as now, WILSON had the world's finest Spudder. Mechanically, it is a long way from the Spudder above to the one at left.

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EXPLORATION ACTIVITIES

AAPG Honor Two Distinguished Geologists

M. M. Leighton, of Urbana, Illinois, chief of the Illinois State Geological Survey, and E. Russell Lloyd, independent consulting geologist of Midland, Texas, have been elected to honorary membership in The American Association of Petroleum Geologists. Symbolizing distinguished service performed in the field of petroleum geology, the certificates of honorary membership will be formally presented at the Stevens Hotel, Chicago, Illinois, on April 25, as a highlight of the 35th annual meeting of the world's largest association of geologists—the AAPG.

For more than a quarter of a century, Leighton has directed the many activities of the Illinois State Geological Survey. His leadership in this field early received national recognition by his election to the presidency of the AAPG in 1931. He received an AB and MA degree from Iowa University and his PhD from the University of Chicago.

Lloyd, consulting geologist, is widely recognized as an authority on the petroleum geology of the Permian Basin of West Texas. He attended Ohio Wesleyan University and received his AB degree in 1905. The scholastic record, which he made at the University won for him a Rhodes Scholarship for continued study at Oxford University, England, during 1905-08. Lloyd has served continuously as an associate editor of the AAPG Bulletin, for the Permian Basin of West Texas, since 1940.

Sohio Transfers Land Office

Sohio Petroleum Company has consolidated its Jackson land department with the Shreveport, Louisiana, office. All geological and land department functions of the company for the Jackson area will be handled through Shreveport. Henry A. McClurg, geologist, and Frances Gill, stenographer, remained in Jackson to operate the area office.

Robert J. Bartlett, previously district landman for Sohio in Jackson, has resigned from the company and will open a private office in Jackson as an independent broker and operator. Also resigning was Lewis G. Ayers, district geologist, who has joined Petersen Drilling Company in a geological capacity.

Arkansas Has Five Oil Pools Two Gas Pools in 1949

Final survey of oil activities in Arkansas during the year 1949 revealed five new oil pools discovered, and two gas pools opened. Two of the oil discoveries were in Columbia County, two in Union, and one in Ouachita, all in the southwest part of the state. Smackover discoveries predominated with three of the discoveries in the Jurassic lime section. One Travis Peak discovery was reported for Ouachita County, while the fifth discovery in Union County was from a shallow Trinity formation.

One gas discovery was discovered in Franklin County, and the other in Crawford County. Total discoveries were larger than those for 1948.

New Producing Area Opened By The Texas Company

The Texas Company has opened a new oil producing area in Pointe Coupe Parish, South Louisiana, one and a half miles northwest of its Fordoche pool. The company's No. 1 Lillie Boudreaux was completed in perforations from 7981 to 7986 ft to flow 206 bbl of 38.8 gravity oil daily through an 8/64 in. choke. Gas oil ratio was 335 to 1.

Barton County Pool Opened

A new oil pool is being opened in Barton County, Kansas, at J. C. Dozier and Kiowa Drilling Company's No. 1 Schneweiss, 1½ miles west of the prolific Kraft-Prusa pool. Prior to acid treatment, the well swabbed 10 bbl of oil hourly from the Lansing lime through perforations at 3231-40 ft. Total depth is 3043 ft in the dry Arbuckle. The Lansing was cut at 3074 ft.

Shallow Oil Pool Opened In Shackelford County

Shackelford County, Texas, is the scene of a new shallow oil pool, opened by J. E. Roberts, Jr., et al, at the No. 1 Tull Newcomb farm, in the Swastika sand. The well is producing an estimated 20 bbl of oil daily on pump from 1886-904 ft. This is the second important shallow sand discovery in Northwest Shackelford in the last month, the first being Anderson and Word-P. S. Kendrick No. 1 E. P. Armstrong farm, which opened a new Hope sand pool four miles away.

Phillips Reported Finding Oil in British Columbia

Phillips Petroleum Company is reported, by a Vancouver newspaper, to have discovered oil in the Peace River area of British Columbia. The paper added further that oil men in British Columbia, Texas, and New York believe Phillips had struck oil at its Lone Mountain test field. Company officials have declined comment on the report, which said the entire area surrounding the well had been blanked with reservations.

Report Oil Show in Alabama

A show of oil has been reported in Clarke County, Alabama, by officials of Humble Oil Company. The test, the No. 1 Marion Wall Davies, will be carried to a greater depth before further drill stem corings are taken. Drilling is underway below 5287 ft at last reports. The only producing wells in Alabama are in the Gilberton field of Choctaw County. The No. 1 Davies is situated in the forks of the Alabama and Tombigee Rivers.

Gulf, Humble Are Testing in Florida

Gulf Refining Company has made location for a new wildcat test in Columbia County, Florida. The well will be the company's No. 1 Kie Vining.

Humble Oil and Refining Company has made two drill stem tests at its Sunnyland field location in Collier County. The first test, which was made of the interval from 11,560-75 ft, recovered mud, 2430 ft of oil, and 90 ft of salt water with a trace of oil. The second test at 11,604-07 ft recovered 8714 ft of salt water with a trace of oil. Drilling is continuing below 11,610 ft.

Bee County Discovery Made

A new gas and oil discovery has been made in Bee County, Texas, by Middle States Petroleum Corporation. The discovery was made at the company's No. 1 Roberson well. Oil and gas were found at two depths. The well flowed at the rate of 3,340,000 cu ft of natural gas and 144 bbl of distillate oil a day through ¼-in. choke from the Luling sand in the Carrizo Wilcox formation. The discovery flowed at the rate of 3,266,000 cu ft of natural gas and 64 bbl of distillate daily from the Massive sand. The well is five miles southwest of the South Ceasar field.

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J. M. Fouts, Jr.

Shell Geologist in L. A.

J. M. Fouts, Jr., area production geologist, Houston, Texas, area, for Shell Oil Company, has been transferred to the Los Angeles office as production geologist for the Pacific Coast region.

Fouts attended the University of Texas at Austin where he received his masters degree in geology and petroleum engineering. Following his postgraduate work in 1939, he joined Shell as an engineer trainee in the Houston region, working in various sections of the Texas-Gulf area. He was appointed area production geologist in Houston in 1948.

Bishop Oil Obtains Canadian Leases

Bishop Oil Company, has obtained an oil and gas lease in the Redwater oilfield of Alberta Province, Canada.

The company's bid for the 160-acre lease in the Redwater field was accepted by the Alberta government recently. The land is designated as the southwest quarter of section 16-58-22, and is situated in the north part of the field. It offsets a producer. The Redwater field produces high gravity oil and is the largest field in Canada.

Continental Completes New Mexico Well

A flowing discovery from the Drinkard zone of East Lea County, New Mexico, has been completed by Continental Oil Company. The well flowed 197 bbl of water in 24 hr on completion test. The flow was through 2/64-in. choke. Oil is coming from perforated section between 6764-804 ft. The well is one mile east of the Warren-McKee field, which produces from the McKee sand of the Simpson, and two miles north of the North Drinkard pool. Oil is flowing from perforated section between 6764-804 ft.

Barnsdall Set Location For 14,000-Ft Wildcat

Barnsdall Oil Company has made location for a 14,000-ft wildcat in Ellis County, Oklahoma. The well will be called the No. 1 Hanan. The test is about 16 miles due east of the Hemphill County, Texas, line. Several shallow dry holes have been drilled six miles due west of the new stake.

Gas Production Indicated At Colorado Test Well

Logan County, Colorado, may soon have its first producing well. Commercial gas production has been indicated in a test at a new well owned jointly by British American and Plains Exploration Company. The well is west of Peetz, Colorado, and near the comparatively new field near Sidney, Nebraska. Drill stem test was made from 5260 to 5270 ft in the muddy sand formation. The brief test indicated a daily flow of 3,500,000 cu ft of gas through a ½-in. choke. Further tests are planned.

Kansas Oil Field Opener Is Nearing Completion

Shelburne and Farmer, Inc., Oklahoma City and North American Producing Company, Wichita, Kansas are attempting completion of a field opening well in Ellis County, Kansas.

Their No. 1 Campbell is awaiting tests after pumping 5 bbl of oil an hour for two days. The well is situated one and one-fourth mile southeast of the Wheatland field. The wildcat well is producing from Arbuckle rocks cut at 3357 ft and acidized after production string had been set two feet in.

Texas Discovery Well Tested

The No. 1 Leberman in Young County, Texas, Mid-Continent Petroleum Corporation and Panhandle Producing and Refining Company's Mississippian oil discovery, flowed 214 bbl of oil in 10 hr, natural flow, and was shut in. Top of production is 4845 to 5854 ft.

Oil Field Opened in Louisiana

Ohio Oil Company has opened a new South Louisiana oil field in Calcasieu Parish, Louisiana. The opener is the company's No. 1 E. W. Brown, Jr., 6½ miles southwest of Vinton in the Black Bayou area. The well flowed 185 bbl of 41.7 gravity oil on a six-hour test through a ¼-in. choke from 7781 to 7782 ft. Through a ⅛-in. choke, the well flowed 7 bbl of oil an hour with a tubing pressure of 1440 lb. It was drilled to 9912 ft.

New Pool Discovered In Borden County

A new pool has been opened in Borden County, Texas, by Barnsdall Oil Company and Pacific Western Oil Corporation. The new pool is 10 miles east of the Vealmore pool. On drill stem test, the No. 1 Wilson, from 7410-25 ft, began flowing 43-gravity oil at the rate of 15 bbl an hour.

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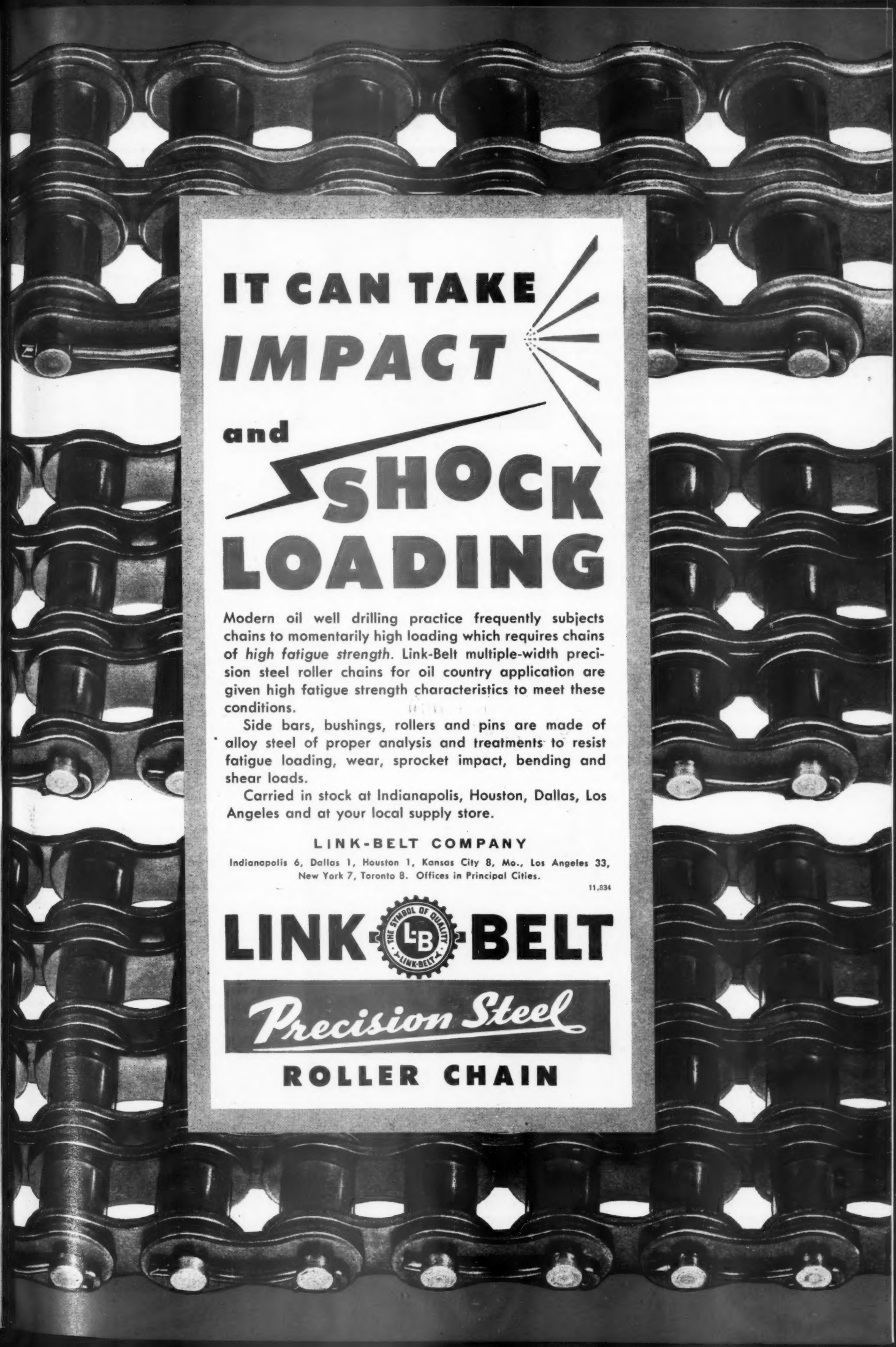
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running tour with men in the industry

▸ **Ira H. Cram,** Houston, Texas, has been appointed to the newly created position of vice president in charge of Continental Oil Company's production department. Cram will also continue in his position as vice president in charge of exploration.

O. L. Fisher, assistant manager of Continental's production department, is promoted to be assistant regional general manager, southern region, Houston. In his new position Fisher will assist in the direction of all of Continental's operations in Texas, Louisiana, New Mexico, Arkansas, and Mississippi. He has been with Continental for more than 23 years.

Fisher will be succeeded as assistant manager of the production department by **H. H. Hinson,** chief production research engineer. Prior to joining Continental, Fisher was with the Bureau of Mines.

▸ Humble Oil and Refining Company has announced the following promotions and transfers:

E. B. Woodell, assistant cycling plant superintendent, Katy gas plant was transferred to Jourdanton gasoline plant as gas plant superintendent.

J. R. Nichols, Conroe gas plant superintendent, was transferred to Pickton gasoline plant as gas plant superintendent. **J. C. Martin,** district chief clerk, Lovell Lake district, became Winters' district chief clerk.

Ira H. Cram

O. L. Fisher

H. H. Hinson

▸ **John S. Goodrich,** Magnolia Petroleum Company, has been named production foreman at Snyder, Texas. He was formerly at Imperial, Texas.

▸ **James D. Wells,** Stanolind Oil and Gas Compnay, has been appointed marine operating superintendent of the Gulf Coast division. He will be stationed in Houston, Texas.

Wells was formerly chief mechanical engineer in Stanolind's manufacturing department. As marine operating superintendent, he will be engaged in Stanolind's offshore operations in the Gulf of Mexico. Before coming to Stanolind in 1948, Wells was employed as chief engineer for the Valley Iron Works in Appleton, Wisconsin.

▸ **Sam Zimmerman,** has moved from Carter Oil Company at Denver, Colorado, to Arabian American Oil Company as senior geophysicist at Dhahran, Saudi Arabia. Zimmerman was chief geophysicist for Standard Oil Company of Egypt, Cairo, before joining Carter.

▸ **E. J. Dupree,** California Company has been named assistant general manager of the production department in New Orleans, Louisiana. Other production department changes in New Orleans are: **G. N. Hile,** appointed manager, gas-plant operations; **E. M. Kipp,** named chief engineer; **C. P. Besse,** named assistant chief engineer; **G. M. Liljenstein,** named assistant chief engineer; **A. L. Vitter, Jr.,** appointed assistant chief engineer, and **J. W. Desmond,** southern exploration division, has been transferred to Brookhaven, Louisiana.

▸ **Robert D. Gensch,** Wichita, Kansas geological department, Cooperative Refinery Association, has been transferred to Great Bend, Kansas, as district engineer for West Kansas. **John H. Nation,** was transferred to West Kansas district in Great Bend as production superintendent. He was formerly superintendent of production at Bartlesville, Oklahoma. **William B. Nation,** district engineer, East Kansas area, Wichita, has moved to Bartlesville as production superintendent, and **Jim Robinson,** material and supply clerk at Bartlesville, moved to Great Bend as district clerk.

▸ **M. L. Morris,** general drilling superintendent at Elmore City, Oklahoma, for Sohio Petroleum Company, has been moved to Pauls Valley, Oklahoma, where he will be superintendent of production and drilling operations.

Kansas AAODC Officers. New officers elected by the Kansas Chapter of American Association of Oilwell Drilling Contractors are: Left to right: J. G. Adkins, Adkins Drilling, Great Bend, vice-chairman for Central Kansas; E. L. McCartney, B & R Drilling, Inc., vice-chairman for the Wichita area; B. W. Burks, Derby Drilling, secretary; and C. H. Todd, Rine Drilling, chairman.

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RESULTS— DOUBLE the normal amount of explosives are used in the Glass Jet compared to guns of equal sizes. MORE explosives mean DEEPER penetration.

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BETTER PERFORATIONS— The Glass Jet maintains a straight sided hole for a greater distance, does not taper-off rapidly, NO CARROT OR SLUG left to plug the holes!

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SOLID STEEL GUN BODY FOR 5 3/4" AND LARGER PIPE— Allows use of a greater charge of explosive in a smaller gun without danger of splitting or sticking. Permits placing jet charge closer to the casing where all its energy is fully realized. Spacing—1, 2, 3 or 4 charges to a foot.

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EXPORT OFFICE: 30 Rockefeller Plaza, New York 20, N. Y.

Some Los Angeles Nomads visitors are shown above. Front row: G. A. Kosciolek, Socar, Buenos Aires, Argentina; A. Swanson, British Petroleum, New Guinea; Paul Hughes, Colombian Petroleum Company, Colombia; S. H. Dykes, International Petroleum Corporation, Qatar; M. Hulshizer, International Petroleum Corporation, Syria. Back row: L. E. McEwen, International Petroleum Corporation, Iraq; R. L. Babcock, Mosul Petroleum (IPC), Iraq; C. T. Blanchet, N. V. Nederlandsche Pacific, Java; S. K. Chattey, Shell Petroleum Company, England; Otto Loeb, Socony Vacuum Oil Company, Venezuela; C. L. Tidwell, International Petroleum, Iraq; and C. L. Rynd, International Petroleum, Basrah.

Nomads Enjoy South American Movies

The Los Angeles chapter Nomads had a big time at the Jonathan Club recently when S. W. "Big Web" Webster of the Dallas office of Emsco Derrick and Equipment Company presented a motion picture showing places, people, and things in Argentina and several other South American republics. Highlights of the full length feature were a drilling operation in Managua, and a nearby crater of gigantic dimensions.

Big Web, introduced by Jim Hughes of Lane Wells Company, has a humorous touch to his descriptive narration that makes it very palatable, and it was thoroughly enjoyed by an unusually large audience. In the absence of Earle Boggess, the meeting was presided over by Ted Forsyth of Emsco.

Left, Ted Forsyth and S. W. "Web" Webster at Los Angeles Nomads meeting at Jonathan Club, Los Angeles, California.

▸ **John A. Diodene,** district petroleum engineer, Darrow district, Humble Oil and Refining Company, transferred to Louisiana division office as district petroleum engineer. He replaced **Joe E. Graham,** who transferred to Grand Isle district as district petroleum engineer. **W. D. Clift,** senior petroleum engineer, Louisiana division office, transferred to Avery Island district as senior petroleum engineer. **S. D. McCarty,** senior petroleum engineer, Louisiana division office, transferred to Eucutta district as senior petroleum engineer.

D. E. Tousley, district civil engineer, and **Andrew M. Gruy,** civil engineer, transferred to Louisiana division office as senior civil engineers.

R. L. Carroll, district petroleum engineer, Avery Island district, transferred to Potash district as district petroleum engineer.

S. F. (Sam) Moore, chief clerk, production department, Imogene district, was transferred to the Scott and Hopper district as chief clerk. He replaced **O. A. Griffin** who transferred to the Greta district as chief clerk. **O. C. Ferguson,** formerly Greta chief clerk, replaced Moore at the Imogene district.

E. C. Hall, chief clerk, Anahuac district, transferred to Lovell Lake district as chief clerk. He was replaced at Anahuac by **H. E. Snider** who transferred from the Maurbro district. **J. R. Almond,** chief clerk, Sugarland district, was transferred to Maurbro as chief clerk.

J. W. Workman, formerly gas plant superintendent, Anahuac gas plant, transferred to Katy gas cycling plant as assistant cycling plant superintendent. **W. A. Hutsell,** gas plant superintendent, Pickton gasoline plant, was transferred to the Anahuac gas plant as superintendent.

F. V. LaFayette, gas plant superintendent at Clear Lake transferred to Conroe gasoline plant. He was replaced at Clear Lake gasoline plant by **J. H. Kinsey,** formerly of Lovell Lake where he worked as compressor plant foreman before his promotion. **W. R. Mathyer,** head cycling plant operator at Katy, succeeded Kinsey as foreman at Lovell Lake.

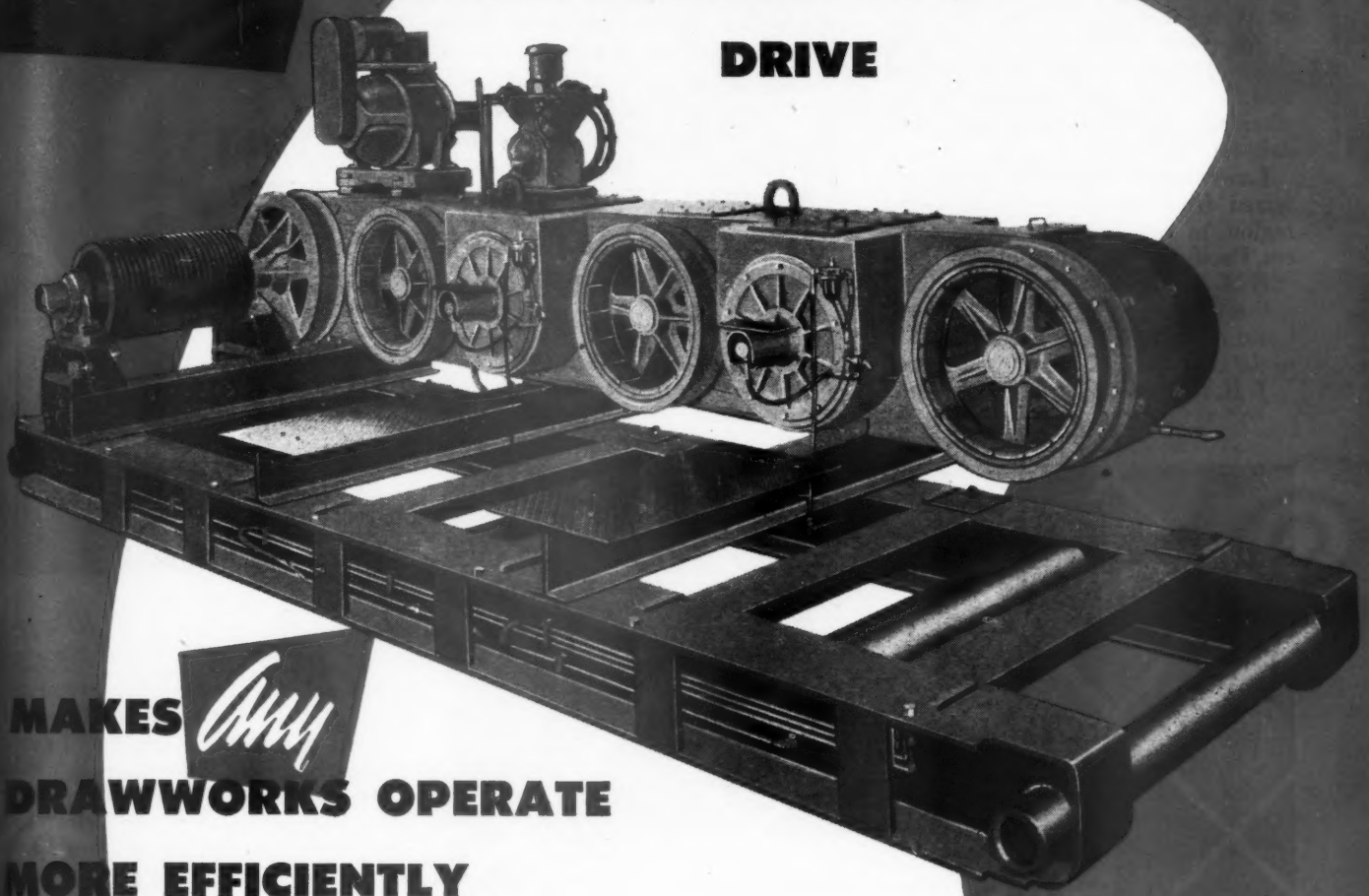
▸ **George T. Briggs,** who began with The Texas Company 23 years ago, has been promoted to assistant division manager, Louisiana division, producing department. Briggs is a native of Lytle, Texas, and is a graduate of the University of Texas, where he received the BBA degree.

Beginning with The Texas Company as a clerk at Houston in 1927, he was transferred to the old Louisiana-Arkansas Division office at Shreveport, in 1929. He was named chief clerk in the division office in 1932.

▸ **John W. Timmins,** general attorney for the Southwest production division of Sun Oil Company, has been elected secretary of the Dallas Petroleum Club. He also was named to a three-year term on the club's board of directors.

▸ **Donald L. Bohannan,** Rio Bravo Oil Company, Ltd., has been transferred to Edmonton, Alta., Canada as petroleum engineer. He was formerly stationed at Casper, Wyoming.

UNIT RIG'S STREAMLINED COMPOUND DRIVE



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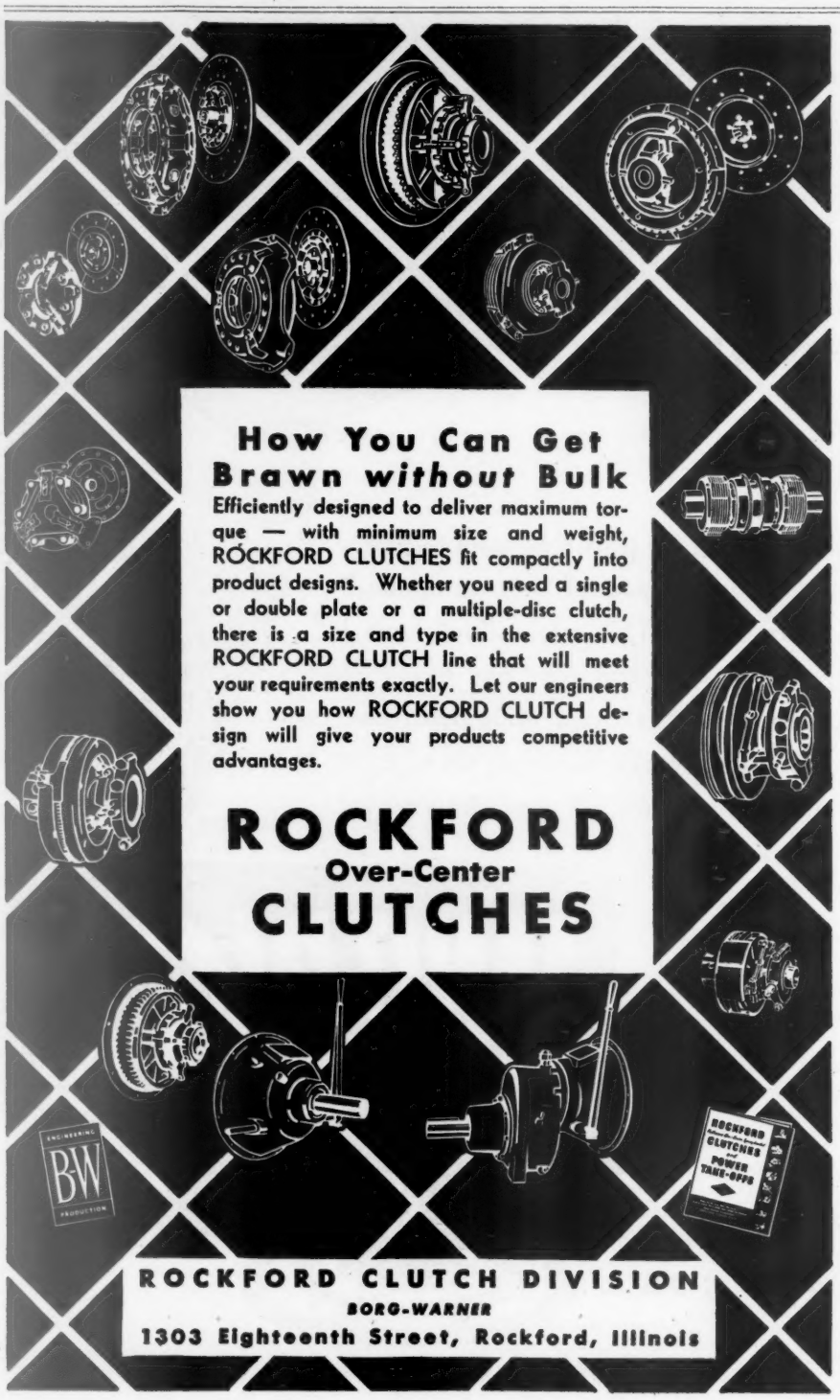
Olen Lane, Continental Oil Company, has been transferred from regional land superintendent, Pacific Coast region, to the newly-created position of regional manager of exploration, Pacific Coast region, Los Angeles, California.

Lawrence E. Graham was transferred from landman, Pacific Coast region, to regional land superintendent, Pacific Coast region, Los Angeles.

R. G. TenEyck, transferred from assistant division geologist, Pacific Coast region, Los Angeles, to assistant to the chief geologist, Houston, Texas.

J. B. Anderson has been promoted from geologist, Pacific Coast region, to assistant division geologist, Pacific Coast region, Los Angeles.

Lane, a native of Oklahoma, joined the company as a leaseman at Los Angeles in 1922. Graham became a production clerk for Continental in Los Angeles in 1926. TenEyck studied geology at Pomona College and Stanford University, and went to work for Continental as a geologist at Los Angeles in 1937. Anderson, who studied geology at the University of California, joined Continental as a geologist at Los Angeles in 1940.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Carl A. Houy

Carl A. Houy, who began as a roughneck in the Texas oil field 13 years ago, has been appointed general superintendent of crude oil production for Deep Rock Oil Corporation.

Houy attended the Schreiner Institute at Kerrville, Texas, then specialized in petroleum engineering at the University of Texas. He began his working career with Humble Oil and Refining at Refugio, Texas, in 1937.

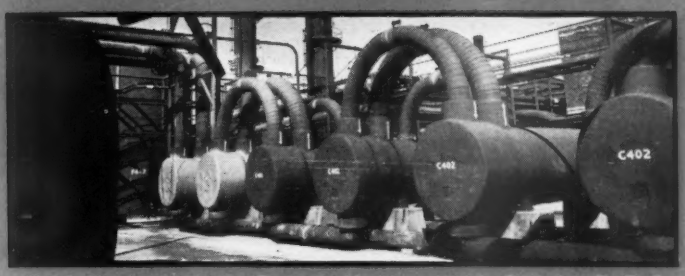
Clarence M. Wanbaugh, veteran Ohio and Michigan oil man, died in Michigan on March 6 at the age of 81. He was Sun Oil Company's drilling tool foreman in the Gladwin district. Wanbaugh received a diamond-studded emblem early this year in recognition of his 55 years of service with Sun Oil.

J. L. White, Jr., former petroleum engineer at Falfurrias, Texas, has been promoted to district petroleum engineer of the company's Shreveport, Louisiana district.

L. A. Scholl, Jr., senior member of the geophysical department of The Texas Company, has been promoted to geophysical consultant on the general manager's staff, producing department. A graduate of Carnegie Institute of Technology, and the School of Mines, Columbia University, Scholl joined the Producers Oil Company, a Texas subsidiary, in 1916.

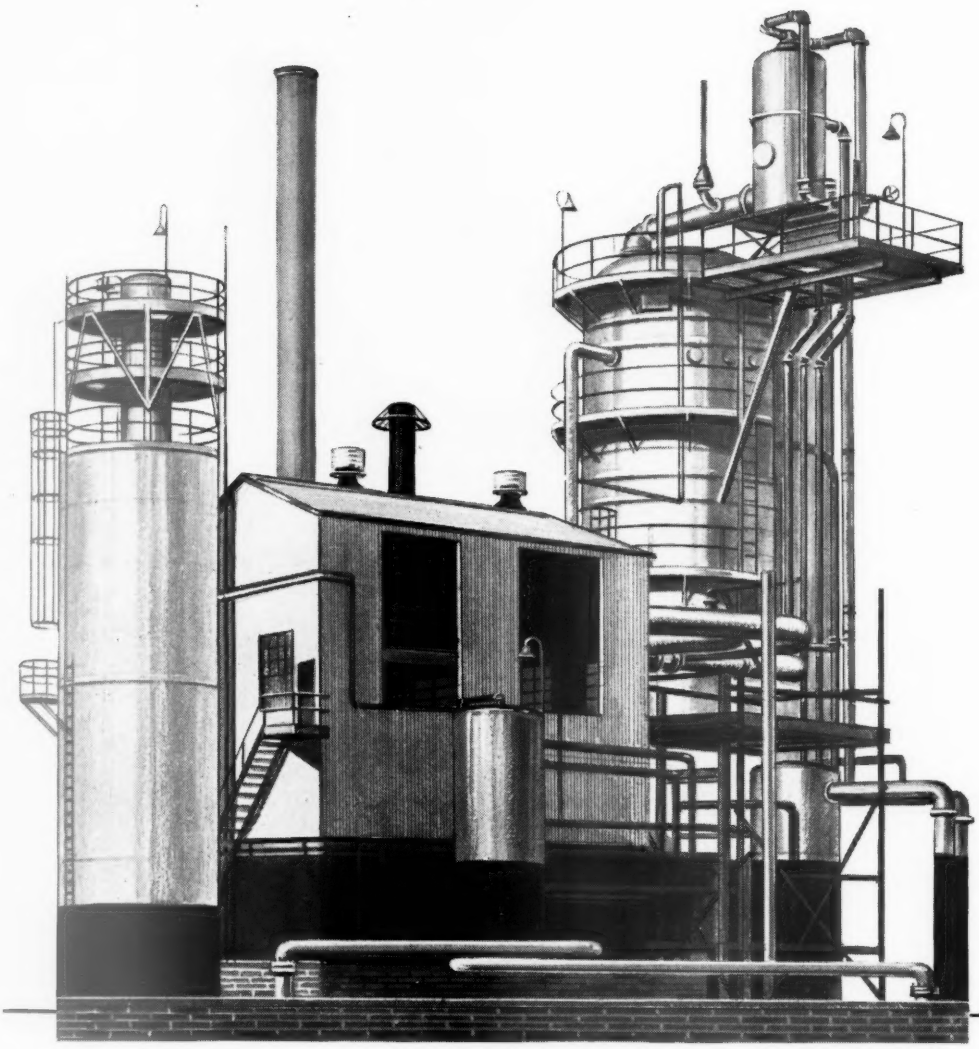
Roy L. Lay has been advanced to division manager, geophysical division, producing department of Texas. Lay was employed with Geophysical Research Corporation for several years after his graduation from Rice Institute in 1928. He joined The Texas Company in 1932.

REFINING AND GAS PROCESSING SECTION



Continental Oil Company's refinery, home offices, and part of tank farm at Ponca City, Oklahoma.

Operating Flexibility



that permits Lube Refiners to choose end products at will

UNION OIL COMPANY NEW FILTROL FRACTIONATION UNIT AT OLEUM, CALIF.

One of America's most flexible lube plants has . . .

6 practical finishing methods available in its new Filtrol Fractionation Unit:

1. Filtrol fractionation of Duo-Sol extracted, propane dewaxed long residuals to produce a complete line of high V.I. motor oil blending stocks.
2. Filtrol fractionation of a phenol raffinate from a wax-free long distillate yielding motor oil blending stocks of intermediate V.I.
3. Contact Filtration of solvent extracted distillate and bright stocks in blocked operation.
4. Contact Filtration of acid treated and straight distillate stocks for industrial and spray oils.
5. Contact Filtration of specially treated phenol raffinates from distillate stocks for turbine and transformer oils.
6. During Contact Filtration operations, the fractionation tower may be used for re-running refinery distillates.

Operating control of this unit on any of these processing methods requires only two men per shift.

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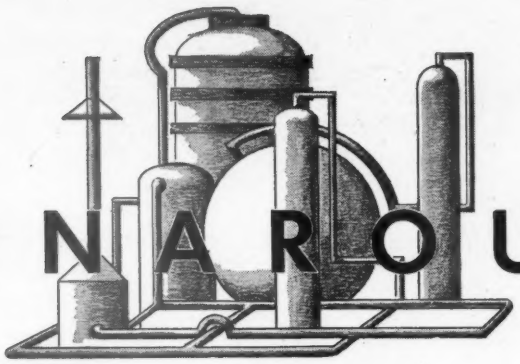
THE TURNAROUND



Jet Fuels From Shale Oil

Billions of barrels of jet engine fuels can be made from shale oil, according to Bureau of Mines' Drs. J. D. Lankford and C. F. Ellis. By hydrogenation 88 per cent will yield premium diesel fuel and good jet fuel. These are heartening statements, showing the *possibilities*. Unfortunately the authors say "Costs are not yet available", obviously true in the nature of things. Here again the Bureau will be very smart to avoid giving the impression of *economic feasibility* by its manner of speaking, when actually the only position supportable by facts is that of *technical possibility*. Wholly erroneous ideas have been planted ere this in the public mind by injudicious generalities of costs, intensified by omission of controlling cost items without mentioning the omission.

Anti-Knock 'Antagonists' Taboo

Keep sulfur, phosphorus, arsenic, and silicon compounds away from gasoline if you expect anti-knock agents to function efficiently, duPont's Dr. H. K. Livingston tells the American petroleum chemists. These compounds appear to unite with metallics like tetraethyl lead to reduce seriously their anti-knock effect. The last three compounds named are more harmful in this way than is sulfur, most common impurity in motor fuel. Metal anti-knocks unite with "free radicals" and prevent their inducing detonation; compounds mentioned above seem to unite with the metal anti-knock and prevent its handcuffing the free radicals, believed to initiate knock.

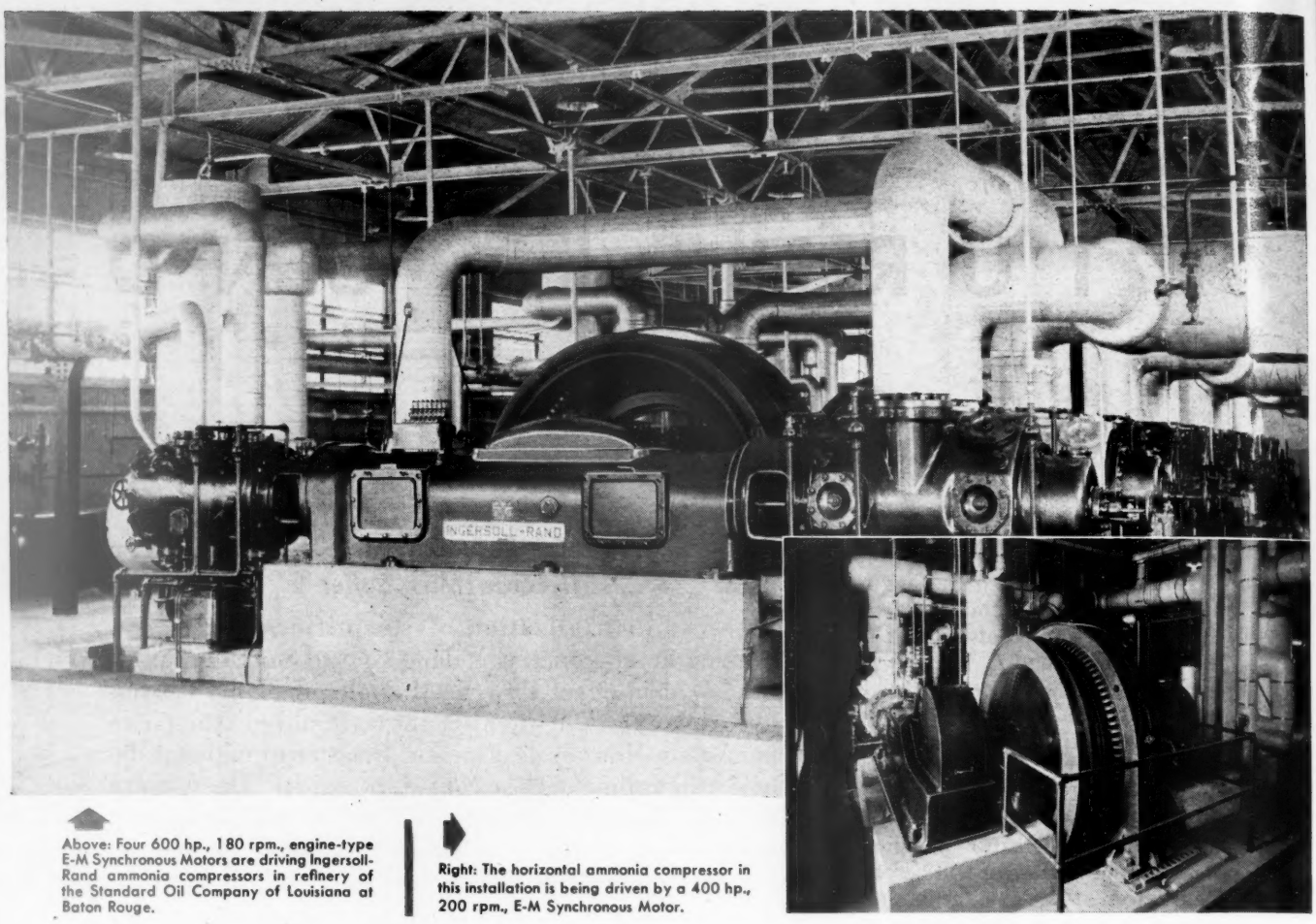
Fundamental Research Lags; National Defense May Suffer

Over-industrialization of scientific research, now booming in this country, is dangerous to our future prospects, said in effect Prof. I. M. Kolthoff of the University of Minnesota, warning the assembled American chemists in Houston last month. Disaster to national defense can follow such a course, he said; "The country that lags behind in fundamental research will be lagging behind in industrial application." Kolthoff viewed recent developments in his 1950 Fisher Award address.

Dr. Kolthoff is one of the outstanding chemists of his or of any time. He points out that Europe has led the field in fundamental research, this country excels in applied research, a situation that will continue "as long as we continue to treat graduate students as children, instead of transferring all responsibility for course work to them." His warnings are supported strongly by the chemical and industrial history of the world. The great majority of our present industrial developments are rooted in the findings of pure science research, work carried out with no vision whatever of the industrial products.

The now-famous "invisible light" combination, which made objects visible to the military sniper on the darkest night and completely mystified the German High Command, came about as result of scientific research on light and optics which had no such industrial or military idea in mind. The most important "stockpile" for this or any country, for peace or war, is that of ever-widening knowledge of fundamental chemical and physical laws and facts. Without these, our industrial progress will soon shuffle to a stop and become dead.

Arch L. Foster



Above: Four 600 hp., 180 rpm., engine-type E-M Synchronous Motors are driving Ingersoll-Rand ammonia compressors in refinery of the Standard Oil Company of Louisiana at Baton Rouge.

Right: The horizontal ammonia compressor in this installation is being driven by a 400 hp., 200 rpm., E-M Synchronous Motor.

ENGINEERING *"The Most Dependable Drive"* FOR BETTER COMPRESSOR PERFORMANCE

● E-M Synchronous Motors are commonly known as "industry's most dependable constant-speed drive," a reputation that seems especially warranted by their year-in-and-year-out dependability in driving the big refrigeration compressors used in refineries and by cold storage establishments and other industries.

Behind this record of dependability are the many refinements in synchronous motor construction perfected by this company over a half century.

When engineering a compressor motor for the best possible performance under the conditions of a particular installation, E-M engineers are in a position to take full advantage of such important E-M developments as Polarized Frequency Control for proper synchronizing—power factor correction—improved motor protection against overload, short circuits, foreign materials—the use of full-voltage, automatic starting when possible. But the biggest single reason for the great performance of these motors is their extra-tough construction from their multi-layer insulation of their stator coil to their welded, rolled steel frames.

For synchronous motors that will function with full efficiency in every installation, come to this headquarters of pacemaking synchronous motor developments. Write now for our publications 175 and 181, or call in your nearest E-M field engineers.

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Aerial view of Fawley refinery.

P 710.1

New and Old Units of Fawley Plant

Since June last year the largest refinery project in England, costing £37,500,000 has been in progress

V. S. SWAMINATHAN

In November, 1946, the Anglo-American Oil Company Limited first announced the modernization and enormous expansion of the Fawley refinery. A year later, the Ministry of Town and Country Planning stated that "the Government has now decided that in the national interest the extension of the Fawley refinery must be approved." Actual work on this largest single refinery project in the U. K., entailing an estimated outlay of £37.5 million started last June.

At present Abqaiq and Dammam crude oil is processed at the existing Fawley refinery to produce motor spirit, gas oil, marine fuel oil and liquid petrolum gases. To meet local needs vaporizing and burning oils are imported as finished products. A total of 18,900 bbl/day of crude is handled for the following volume percentages of finished products:

Motor spirit 25.5: Gas oil 42.0: Marine Fuel Oil 25.5 and Commercial Gases 0.5.

Initial distillation is carried out with two crude batteries constructed to the company's design. The first of these is a shell still, operating in conjunction with one atmospheric pipe still and one vacuum pipe still. The second has three shell stills and a small atmospheric pipe still. To complete this unit there is a pipe still. Both the crude batteries operate for a 10 per cent straight-run naphtha cut for reforming. A 42 per cent gas oil fraction is then taken, leaving a 33 per cent reduced crude residue, part of which is put to marine fuel blending tanks and the balance fed to No. 1 cracking coil.

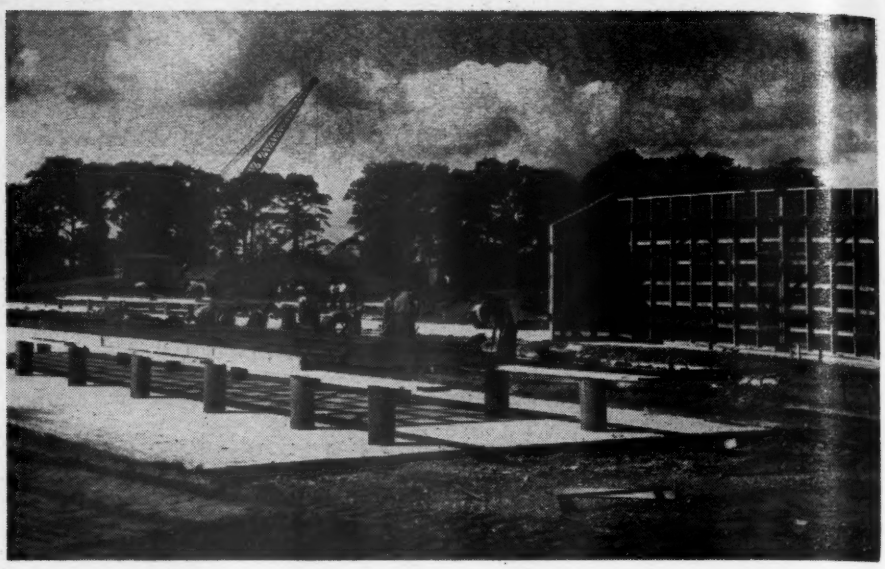
Both coils are of modified Cross type. Reduced crude is fed to No. 1 cracking coil at a fresh feed rate of 3200 bbl per day and at 890-895 F coil outlet temperature, to give a yield of 28 per cent gasoline of 71 leaded O.N., 72 per cent of tar and about 3.5 per cent of gas. Tar from this operation is blended with straight reduced crude for marine fuel for the Southampton port. Reforming naphtha is fed to No. 2 cracking coil at a rate 2800 bbl per day fresh feed rate at a coil outlet temperature of 1015 F on a once-through coil only basis, for a yield of 85 per cent gasoline of 75 leaded O.N., 3.5 per cent of tar and 11 per cent of gas.

EXCLUSIVE

All gases from cracking coils are piped under pressure to a gas absorption plant, where they are stripped of entrained gasoline in a suitable fractionating tower. The stripped gas is piped around the refinery as furnace fuel. Light cracked naphthas are fed to a stabilizing plant for removal of light ends. Here butane and propane are also separated and, after a caustic soda wash to remove mercaptans, they are passed to the filling shed for bottling and dispatch. After completion of the stabilizing process, the straight-run gasoline and cracked naphthas are blended before sweetening. The latter process is carried out in a continuous plant of 5000 bbl per day capacity, using the "Doctor" process. On its completion the gasoline is inhibited against gum formation and receives an addition of 1.2 cc Imperial gallon of TEL before being pumped to finished storage. In addition to the sweetening plant there is a 3960 bbl per day continuous naphtha acid treating plant.

The old refinery is equipped to manufacture and distribute bitumen in bulk and packages. When operating on Lagunillas crude, No. 1 crude battery has a capacity of 8000 bbl per day with an approximate yield of 50 per cent bitumen. The refinery's own drum-making plant has a daily capacity of 3000 finished containers. Oxidized bitumens are produced from a 34,000 tons per year plant.

The refinery's despatch facilities provide normal filling and transport arrangements by road, rail, and sea.



Construction camp—beginning first hut.

The plant is completely independent of outside electricity and steam supplies. Fawley has a modern boiler and a generating house situated in the center of the refinery. The generating station includes two English Electric turbo-alternators supplying 750 K.W. each and one Brush a-c diesel set generating 300 K.W. When working at a maximum, peak load lies between 1500 and 1700 K.W. With refinery working under normal pressure steam, raised in two Babcock and Wilcox tube type steam boilers and two Nesdrum boilers, produces 50,000 and 40,000 lbs of steam per hour each respectively. An auxiliary boiler house with two Stirling boilers of 10,000 lb steam per hour capacity is available. Cooling water for the refinery is drawn from Southampton Water.

The staff comprises 35 chemists and assistants, providing a 24-hour service in the refinery laboratories. There is a separate engine testing laboratory, housing two Co-operative Fuel Research units for investigations on octane fuel ratings and engine perform-

Intermediate tankage and crude oil plants.

ance. There are facilities for storing 200,000 tons of crude oil, intermediate and finished products. These include normal and floating roof tanks. A complete system of fire protection is in operation. The refinery has its own medical department.

Soon after the war the Anglo-American Oil Company Ltd., realized that there will be a dollar shortage when the Marshall Aid ceases, and took steps to reduce the dollar component in the cost of the products it will distribute in the United Kingdom by refining them on the spot from Middle East crude oil. Its basic plans envisage a crude import of approximately 5,500,000 long tons a year. Flexibility will be the keynote of this largest single refinery project in the United Kingdom and Europe, permitting appreciable variation of product offtake but, broadly speaking, the following outputs are planned.

	bbl per day	tons per year
Crude Naphtha and White Spirit	42,500	1,800,000
Kerosines	6,000	290,000
Diesel fuels and gas oils	14,000	700,000
Light Fuel Oils	6,000	300,000
Bunker Fuel	30,000	1,800,000
Asphalts	3,500	200,000
	102,000	5,090,000

Nine-tenths of the product output will be tanker-borne. New plants are therefore being erected on the Codland Estate adjoining existing Fawley Refinery. An area of 1400 acres is available, of which 970 acres will be required for the present scheme. When in full operation it will contribute nearly one-fourth the refinery output of the United Kingdom. Apart from lube oils, aviation spirit, and certain specialized products, it is anticipated that the new refinery will almost entirely satisfy the United Kingdom demand for Esso products. The total storage capacity for crude oil will be about 15 days supply. Nearly 25 days output of refined products will be stored. At present exports are not specifically envisaged but it is hoped that these may materialize in the future. Production of petroleum chemicals is now under consideration. The catalytic cracker operation will yield substantial quantities of unsaturated gases, forming the starting materials for the manufacture of such petrochemicals.

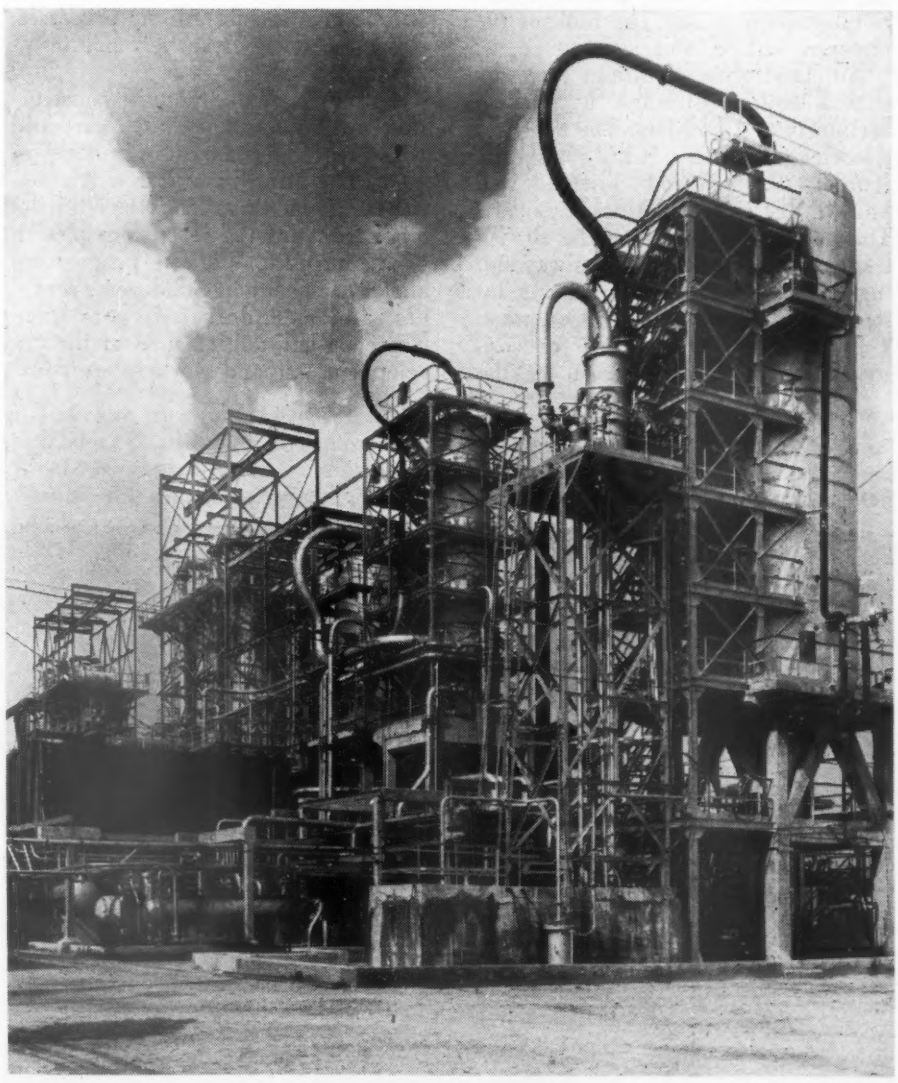
The selection of the Fawley site for the new refinery was prompted by the fact that it involves the extension of an existing plant, which will permit a progressive and comparatively rapid utilization of the new facilities. Moreover, for the distribution over the whole of Great Britain and Northern Ireland of such a large volume of oil products as Fawley will produce economically, the site on Southampton was deemed the most advantageous. Furthermore, Southampton Water has excellent sheltered deepwater harbor facilities.

Docks are being designed basically for 26,000 ton tankers, although consideration is given to so spacing berths that tankers up to 700 ft long (37,000 tons) can be berthed there, as and when they become available. Navigational and berthing facilities are ideal at Fawley for all ocean, coastal, and local tanker operations associated with the refinery project.

To summarize, there is a safe and sheltered anchorage (60 to 70 ft low water ordinary spring tide) available to tankers in Cowes Roads, some 5¼ miles from Fawley. The normal minimum depth of water in the navigable channel between the anchorage and Fawley is 36 ft low water ordinary spring tide, and 38 ft low water ordinary neap tide. Ample foreshore space is available for erecting additional ocean tanker jetties and suitable berthing accommodation for coasters, local bunkering vessels, and barges. Fawley's comparative "isolation" from all other shipping activities and tanker operations provides a safety factor in handling the large volume of concentrated tanker operations involved. The unique double tide and open water conditions, together with deep water berths, enable fully laden ocean tankers to swing, berth and unberth at all states of tide, day and night. This important double tide features does not obtain at any other potential U. K. refinery location.

Standard Oil Development Company is primarily responsible for the design of refinery units, and in making them suitable to produce the quantity of products required by the "Anglo" using Middle East crudes. The refin-

Atmospheric and vacuum units.



ery units are being processed largely and erected under the supervision of the Foster Wheeler Corporation of the U.S.A. Much of the work in Britain is being done under the supervision of their affiliate, Foster Wheeler, Ltd. The refinery consists of three main units—(a) a distillation unit of pipe stills of 60,000 bbl per day capacity, feeding one atmospheric and one vacuum column: (b) A fluid catalytic cracking unit (whose design is based on the S.O.D.Co.'s experience, and incorporates the latest refinements in separation of finely divided catalyst) with an output capacity of 37,000 bbl per day and (c) an Edeleanu plant for sulphur reduction. There are other treating and sweetening plants for gasoline. The catalytic cracking plant will take gas oil as feed stock and 50 per cent of the output will consist of good quality petrol.

Late in September 1000 tons of American machinery urgently needed for work on the new refinery reached Southampton in the freighter "Musquaw" from Norfolk, Virginia. During the next three years nearly 100,000 tons of machinery and materials for the refinery will be handled at the Southampton docks. The bulk of the material will be American.

Administrative buildings are designed and constructed by British architects and builders. The docks of American design are being studied by Rendel, Palmer and Tritton, well known British consulting engineers. The Southern Division of the British Railways will install new railway sidings. Fresh water wells are being installed by C. Isler and Company. Temporary power facilities for construction purposes are met by the Southern Electricity Board, who will also install a tie line and a large substation to provide the electricity requirements of the refinery. The latest appliances for minimizing air and water pollution will be installed. No sulfuric acid and its attendant fumes will be involved in refining processes, which is an important advance in oil refining technique.

Medical center—water massage machine, infra red lamp, etc.

Employment on refinery construction was about 2600 last year, and will rise to a peak of over 4000 in 1950. The Ministry of Labor is cooperating to make available the requisite labor force for the speedy completion of the project. Work is progressing ahead of schedule. Bulldozers, scrapers, and mechanical diggers have cleared a substantial slice of the development site and workers are pouring concrete into shells of temporary huts, which will house a building force of 500 men.

Apart from living quarters, a cinema seating 500 persons is now ready. Other initial operations include installation of a field power plant and telephone system and the building of a huge permanent steel-framed combined workshop and warehouse, 800 ft long and 140 ft wide. This will house the most up-to-date travelling cranes, latest types of machine tools, most modern systems of ventilation and lighting, all designed for the maximum comfort of workmen and to conduce the maximum efficiency.

As now planned, the Fawley refinery project will take about three years to complete. But it is anticipated confidently that initial operation of the units will be possible by the end of 1951. Anglo-American is keen that the refinery must be working by 1952 when a crisis in Britain's dollar balance is foreseen following the termination of the ERP. Its operation is expected to make a two-fold contribution to Britain's balance of payments. In the first place, it will reduce the cost of crude imports as compared with the equivalent finished products, which is reckoned at 20-30 per cent. Secondly, it will replace the Western Hemisphere by the Middle East as the source of crude oil, from which the products distributed by the "Anglo" will be refined. As the refinery feed will be Middle East crude under Jersey's purchase agreement with the Anglo-Iranian, or from its share in the output of Iraq Petroleum, the dollar component in the cost of crude will be reduced correspondingly. When in full operation the refinery will employ 2500 persons, compared with 900 at present. * * *

Refinery site scrapers.

PLATFORMING

Operating costs range 30 to 37 cents per barrel of charge—plant cost $600,000 for 5000 bbl a day unit.

VLADIMIR HAENSEL

Vladimir Haensel

Vladimir Haensel received his BS from Northwestern University in 1935 and his MS from the Massachusetts Institute of Technology in 1937. He joined Universal Oil Products Company, assisting Professor V. N. Ipatieff. In 1939 he helped to set up the Ipatieff high pressure laboratory at Northwestern University. He received his Ph.D. from Northwestern in 1941, and returned to Universal as a research chemist. From February to July, 1945, Haensel inspected the German synthetic oil plants as a member of the Technical Oil Mission for the Petroleum Administration for War. Since August, 1945, he has been the co-ordinator of the cracking research division of Universal Oil Products Company.

At the last WPRA meeting, an announcement was made of a new process for improving straight-run or natural gasoline. The process is called "Platforming" and represents the reforming of gasolines in the presence of hydrogen using a platinum catalyst. It is well known that there are tremendous quantities of straight-run and natural gasoline stocks that are becoming less and less marketable because of their low octane number. The realization of this situation is not a sudden one, and the petroleum industry has been extremely active in attempting to convert these stocks into a suitable motor fuel. A tremendous amount of work has been done on noncatalytic processes such as thermal reforming and on catalytic processes such as hydroforming and desulfurization. Although the thermal and catalytic processes have come into commercial application, they do not provide an ultimate solution for the production of high yields of high octane motor fuel from the straight-run and natural gasoline stocks. Over the years of research on the conversion of these materials into more valuable products, the fundamental ideas were formulated by our organization which outlined the ultimate goal and ways in which such a goal could be achieved. First of all, it was realized that the ultimate process should be a catalytic one, free, as much as possible, from the undesirable thermal effects. The reason for this is that thermal treatment or a high temperature, high pressure treatment in the absence of catalysts gives rise to reactions that are difficult to control and as a result a large portion of the liquid charge is converted into waste gas. Thus, it became apparent that in order to achieve this goal, one had to operate using a catalyst at conditions under which thermal reactions are essentially absent. Next, it was realized that such a catalytic process had to be made up of a number of chemical reactions as gasolines contain different hydrocarbon classes, each class requiring a different chemical reaction so that the members of this class can most efficiently be converted into more valuable components. Furthermore, it became apparent that the rearrangement and conversion of the charging stock had to be extensive because there is no simple method of separating the products of the reaction from the charging stock. Having established the fundamental principles of such an idealized process, it was necessary to find a suitable catalyst that could perform all these functions and at the same time have one other extremely important feature. This particular feature is the elimination of the need for catalyst regeneration, as regeneration is a costly and complicated operation. One merely has to consider the fact that no charging stock is processed over the catalyst during regeneration to realize that the efficiency of a nonregenerative operation and its inherent simplicity provides a practical solution for a refiner who cannot afford a large investment in a plant that remains nonproductive for a good share of the time.

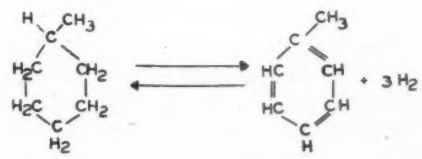
Over the past years, we have found that the Platforming operation approaches very closely to the ideal solution for the reforming of straight-run and natural gasolines. The functions of the catalyst in carrying out the desired reactions under conditions wherein wasteful side reactions are virtually eliminated have been realized in the laboratory, pilot plant, and commercial operation.

At the present time, we wish to discuss the various phases of Platforming. These are:

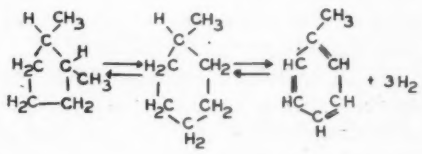
(1) The chemistry of the process.
(2) Operating variables.
(3) Properties of the Platformate.
(4) Platforming of mixed straight-run cracked gasolines.
(5) Economics of the Platforming process.
(6) Operation of the first Platforming unit at the Old Dutch Refining Company at Muskegon, Michigan.

Chemical Reactions Involved in Platforming

There are three major reactions that occur in Platforming of a straight-run gasoline. The first of these is the dehydrogenation of naphthenic hydrocarbons to the corresponding aromatic hydrocarbons. This is illustrated by the following:



wherein methylcyclohexane is converted to toluene and hydrogen. As is well known, straight-run gasoline contains a substantial amount of naphthenic hydrocarbons, of both the six-membered ring type and the five-membered ring type, and in the latter structure the dehydrogenation reaction is preceded by the isomerization reaction:



Under Platforming conditions the reactions of dehydrogenation of naphthenic hydrocarbons are very rapid and these reactions contribute substantially to the octane gain and heat of combustion of the gasoline. They are also highly endothermic, that is,

they require a high heat input and they result in some volumetric shrinkage as the aromatic product is denser than the parent naphthene. Thus, for example, if the charge consisted of pure methylcyclohexane and if it were all converted to toluene, the theoretical yield of toluene would amount to 83.3 per cent by volume of the charge with an octane number increase of about 50 units. The naphthenic content of straight-run gasolines varies considerably, but, assuming an average value of about 40 per cent, the maximum volumetric yield due to dehydrogenation to aromatics would be about 93 per cent assuming complete conversion and no other reactions.

Another important reaction in Platforming is the opposite of dehydrogenation from the standpoint of yield and heat of reaction. This is the reaction of hydrocracking wherein a high molecular weight hydrocarbon is decomposed into lower molecular weight compounds. This is not the reaction of thermal cracking, where a paraffin is cracked indiscriminately along the hydrocarbon chain, nor is it the reaction of catalytic cracking where the product consists of lower boiling paraffins and olefins. It can be considered as a simultaneous cracking-isomerization-hydrogenation reaction, as shown by the following:

$$H_3C\text{-}C\text{-}C\text{-}C\text{-}C\text{-}C\text{-}C\text{-}C\text{-}C\text{-}CH_3 + H_2 \longrightarrow$$
$$H_2H_2H_2\ H_2H_2H_2H_2H_2$$

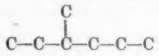
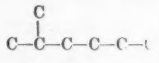
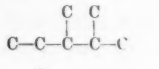
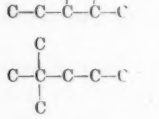
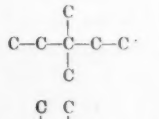
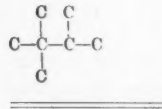
$$H_3C\text{-}C\text{-}C\text{-}C\text{-}CH_3 + H_3C\text{-}\underset{CH_3}{\overset{H}{C}}\text{-}\underset{H_2}{C}\text{-}CH_3$$
$$H_2H_2H_2 \qquad\qquad$$

This reaction, as can be seen, produces isopentane and normal pentane from decane. In actual operation, the break in the molecule occurs not only in the middle, but also to the right and left of the center, so that butane and hexane, as well as propane and heptane, are formed also. Assuming for the time being that two pentane molecules are formed, the volumetric yield of such a reaction at 100 per cent conversion is 118 per cent along with an octane number gain of more than 100 units. As stated before, there is a small loss to propane and lower hydrocarbons with the result that only a part of that high gain in volume and octane number can be realized.

It is, therefore, apparent that the hydrocracking reaction balances the dehydrogenation reaction in that it provides for a lower density product and absorbs a part of the hydrogen which is liberated in the dehydrogenation reaction. The reaction is also exothermic and, therefore, provides some of the heat of reaction required for the dehydrogenation step. The hydrocracking reaction is less rapid than the dehydrogenation reaction as will appear from data to be presented in the next section.

The third major reaction in Platforming is isomerization. This reaction was mentioned earlier, when it was stated that five-membered ring naphthenes undergo isomerization to six-membered ring naphthenes prior to the conversion into aromatics. Likewise, the isomerization of paraffins proceeds readily at Platforming conditions. In the case of normal heptane, this reaction is faster than hydrocracking as shown by Graph 1 in which the extent of isomerization and that of hydrocracking are plotted against contact time measured as reciprocal space velocity. It will be observed that as the space velocity is reduced the extent of isomerization reaches a maximum value at a space velocity of about 5. At lower space velocities the hydrocracking of the isomerized compounds reduces the net yield. The composition of the isomerized product is of interest in that nearly every possible heptane isomer is produced. Thus, at a space velocity of six, the composition of the heptane fraction exclusive of the normal heptane charged is:

TABLE 1. Treatment of normal heptane with Platforming catalyst in the presence of hydrogen.

Compound	Per cent in C_7 cut, excl. of n-C_7H_{16}
	46.2
	30.6
	10.9
	4.7
	4.5
	3.1

The hydrocracking reaction that accompanies the isomerization reaction of heptane gives, as expected, propane and butane as the major products, the isobutane-normal butane ratio in the butane fraction being about one. Both higher and lower paraffins also undergo extensive isomerization.

In addition to the three major reactions that occur in Platforming, there are other important reactions. These include dehydrocyclization, wherein paraffins are converted directly to aromatics, and desulfurization, wherein virtually all of the combined sulfur is converted to hydrogen sulfide.

The question naturally arises as to how we balance the extent of the various reactions that take place in platforming in order to attain the optimum yield octane relationship. This is accomplished primarily by proper selection and preparation of catalyst. Secondarily, the operating conditions are adjusted to give the desired product distribution.

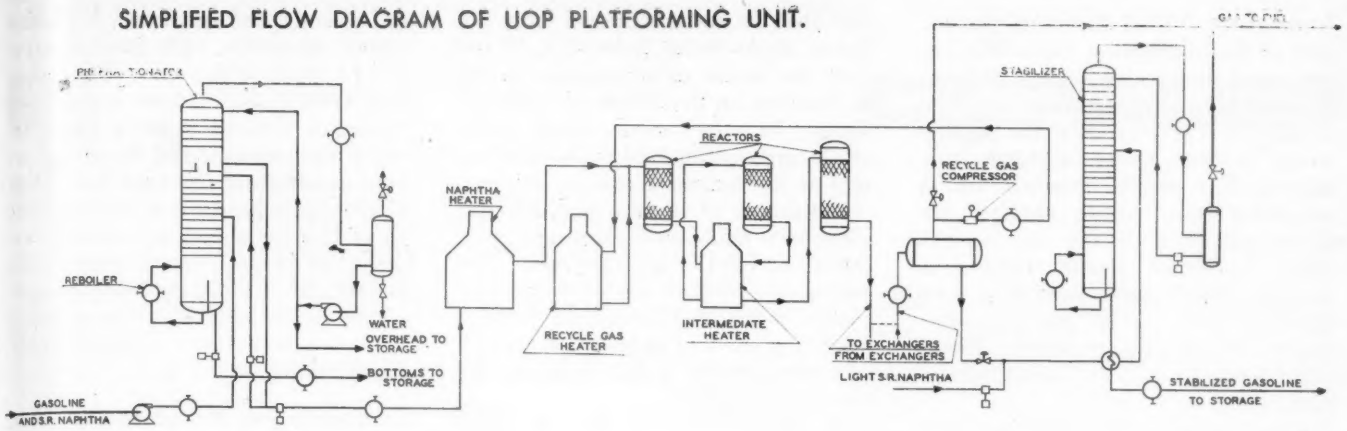
It should be emphasized that Platforming is unique among reforming processes from the standpoint of low methane production. In a process of this kind, methane production is undesirable from the standpoint of severe loss of liquid product, high exothermicity of the reaction that forms methane and high hydrogen consumption. The extremely low methane production is beneficial on the basis of high liquid yield and control of the reaction at all times. For example, with other catalysts, a high pressure condition leads to excessive methane formation and an exothermic condition is reached that is difficult to control. With the Platforming catalyst, on the other hand, a high pressure operation gives only a small amount of methane and as the temperature is increased the selective hydrocracking reaction is quenched by the dehydrogenation reaction. Thus, there is no tendency to develop run-away temperatures in the operation of the Platforming process. In addition it should be pointed out that another undesirable reaction, characteristic of some reforming processes, and involving the formation of high molecular weight compounds, is essentially eliminated in Platforming. Therefore, Platformates do not require rerunning.

Operating Variables

There are four major operating variables in Platforming. These are temperature, space velocity, which represents barrels of charge per hour divided by barrels of catalyst, pressure and hydrogen recycle rate. Over the past few years we have obtained a considerable amount of information both in the laboratory and in pilot plant operation concerning these variables with a number of commercial gasolines and pure compounds as charging stocks. The study of these variables as well as that of catalyst composition has been carried out in 11 laboratory and pilot plant units, ranging in throughput from one gallon to 4 bbl per day.

As might be expected, the relationships between these operating variables are extremely complex and it would not be practical in this paper to discuss the many details necessary

SIMPLIFIED FLOW DIAGRAM OF UOP PLATFORMING UNIT.



to obtain a satisfactory correlation of operating conditions. We can only show certain illustrative effects of major variables but it should be pointed out that these effects are influenced to a considerable degree by the particular type of charging stock and the values of the other variables employed. When a major variable is changed it usually is necessary to make an adjustment in the other variables to obtain optimum performance, that is, optimum performance from the standpoint of yield-octane number relationship as well as from the standpoint of catalyst life.

These factors must be kept in mind when examining the data presented in the discussion.

Table 2 shows the results obtained in processing an initial boiling point to 350 F boiling range straight-run stock from mixed paraffinic and naphthenic crudes.

The results shown indicate first of all that Platforming is a relatively low temperature operation, and it is through the use of these mild conditions that the reaction remains a truly catalytic one, with no interference from undesirable thermal effects. The results also show the increase in the aromatization reaction as well as in hydrocracking with increased temperature at the operating conditions employed. As both reactions contribute largely to the octane number gain it is not surprising that high octane numbers can be realized.

The effect of pressure as the major variable has been investigated and typical results are shown in Table 3. The charging stock consisted of a 247-404 F Mid-Continent straight-run naphtha. It will be observed that a low pressure operation produced the most aromatics and the least amount of hydrocracking. At the highest operating pressure, shown in the table, 900 psig, a larger part of the improvement in octane number is due to the hydrocracking reaction, as in this case the amount of hydrocracked material (as measured by per cent over at 212 F) is almost twice that obtained at the lowest pressure. The yield of butane is large at the highest pressure and in this particular case a small butane excess was obtained over that required for 10-lb RVP gasoline. Thus, it becomes apparent that by varying the operating pressure the Platforming operation can be carried out to produce either a more aromatic gasoline, which means more hydrogen production and a gasoline of lower volatility, or a more volatile product with a lower aromatic content and lower hydrogen production.

The range of pressure used in the Platforming operation is limited at the higher value by economic considerations as well as by temperature required to produce a given quality Platformate.

As the pressure is increased a limit is reached where thermal reactions may occur to such a degree that the yield-octane relationship deteriorates. The lower pressure limit is set by the decrease in the desired amount of hydrocracking as well as by possible carbonization of the catalyst. The lack of carbon formation in the Platforming operation is due to the continuous prevention of formation of materials which lead to carbon, this prevention being carried out by hydrogen. If the partial pressure of hydrogen is maintained at a low value over prolonged periods of time there is a tendency for carbon formation to occur. Such a condition is prevented by providing a reasonable recycle gas rate thereby making the process a truly nonregenerative one.

It has been pointed out earlier that the dehydrogenation reaction is a relatively fast reaction whereas hydrocracking is considerably slower. A study of the effect of space velocity substantiates this statement. Tables 4 and 5 show the results obtained in processing a Mid-Continent naphtha at various conditions in which space velocity was a principal variable. It will be observed that, according to Table 4, a change in space velocity

TABLE 2. Effect of temperature.

Run	Charge	1	2	3	4
Ave. cat. temp. F		813	843	873	903
Yield of C_4^+, liq. vol. per cent of chg	100.0	98.0	96.8	95.0	91.6
RVP	5.5	6.0	6.7	8.3	11.4
Octane numbers:					
F-1 clear	60.8	67.5	74	80.5	89
F-1+3 cc. TEL	80.2	85	88	92.5	98.5
F-2 clear	60.7	65	70	75.5	82
F-2+3 cc. TEL	80.0	82	85	88	91.5
% aromatics in product	9	19	27	35	45
% over @ 212 F	31	34	36	41	46
Hydrogen production, cu ft/bbl		166	318	420	466

TABLE 3. Effect of operating pressure.

Run no.	Charge	1	2	3
Pressure, psig		500	700	900
Yields, vol. per cent of charge:				
C_4^+ Platformate		92.6	92.9	93.2
C_5^+ Platformate		86.5	86.1	83.5
10lb RVP Platformate (a)		97.3	96.4	92.4
Octane no. of 10 lb RVP Platformate				
F-1 clear		30.6	85.1	84.1	84.8
F-1+3 cc TEL		52.8	95.2	94.3	94.9
% aromatics, based on charge		7.1	53.9	47.9	45.4
% over @ 212 F+loss		0	12.7	18.9	22.7
Hydrogen production, cu ft/bbl		685	488	287	

(a) With outside butane 4.7 per cent at 500 psig and 3.5 per cent at 700 psig.

TABLE 4. Effect of space velocity.

Mid-Continent naphtha 230—395 F
Catalyst A

Test no.	Charge	1	2	3	4
L.H.S.V.		4.9	3.9	3.0	1.9
C_4^+ yield, vol. per cent		95.6	95.4	95.1	94.1
RVP		4.5	5.2	6.4	6.9
F-1 clear	35	70	74	76.5	82
F-1+3 cc. TEL	59.5	86	89	90.5	93
% aromatics in product	7	37	39	39.5	41
% over @ 212 F+loss		8.3	13.5	16	24
H_2 production, cu ft/bbl		495	475	470	430

TABLE 5. Effect of space velocity.

Mid-Continent naphtha 230—395 F
Catalyst B

Test no.	1	2	3
LHSV	2.0	3.0	4.0
C_4^+ yield, vol. per cent	91.8	93.9	95.1
RVP	12	10	6.9
F-1 clear	85	81	76
F-1+3 cc. TEL	95	93	90
% aromatics in product	43	40.5	38
% over @ 212 F+loss	32	25	17

from about 5 to 2 increased the extent of hydrocracking three-fold (as measured by per cent over at 212 F), whereas the aromatization reaction, already very extensive at the highest space velocity, was affected only slightly. The results obtained with a somewhat more active catalyst are shown in Table 5 (in this series) where a higher octane number is reached at the same operating conditions. These results are also summarized in Graph 2 correlating the research octane numbers and reciprocal space velocity.

The discussion of the effect of operating variables brings out also the flexibility of operation. As has been shown, we can vary the ratio of the reactions that occur in Platforming so that it is possible to obtain a number of volatility-octane relationships instead of one single relationship as is true in the case of thermal reforming. This flexibility of operation permits us to produce fuels that have a range of volatilities depending upon the overall refinery economics.

Properties of Platformate

The previous discussion has dealt with the product of Platforming from the standpoint of aromatic concentration, volatility, and octane number. At this point it is worthwhile to mention briefly some of the other properties of the Platformate. These are sulfur contents, storage stability, and road performance.

Table 6 shows the sulfur contents of the charging stocks and products and the corresponding leaded research octane numbers at a variety of severities.

The results shown in Table 6 indicate that the sulfur removal from different stocks varies from 88 to 99 per cent, the initial sulfur content having no bearing on the extent of desulfurization. In other words, high sulfur stocks are desulfurized to the same extent as low sulfur stocks.

A number of storage stability tests have been made on Platformates produced in pilot plant operation. The following is a summary of the storage results using a Platformate from a Michigan stock. The tests were made in vented bottles at 100 F and no inhibitor was added.

It will be observed that the Platformate is very stable in storage. The addition of inhibitor is required only for the purpose of retaining tetraethyl lead in solution in the same manner as is necessary for straight-run gasoline. A slight drop in color has been observed to occur over the period of storage.

A considerable amount of work has been done by our automotive and aircraft department in connection with the road performance of a variety of Platformates. It is planned to present a paper shortly dealing with the properties and performances of Platformates; therefore, only brief mention will be made at this time. It is known that most gasolines have a road performance equivalent to a value between the research and the motor octane numbers. It has been found that Platformates have a road performance value that equals or substantially exceeds the research octane number, the magnitude of this gain being dependent upon the nature of the charging stock and the severity of the Platforming operation.

TABLE 6. Sulfur.

Source	Charge	Product	Per cent reduction	F-1+3 cc. TEL
Michigan	0.045	0.0027	94	96
Gulf Coast	0.019	0.0023	88	93
Mid-Continent	0.040	0.0042	90	95
California (1)	0.102	0.0005	99	95
California (2)	0.14	0.0036	97	97

TABLE 7. Storage stability tests.

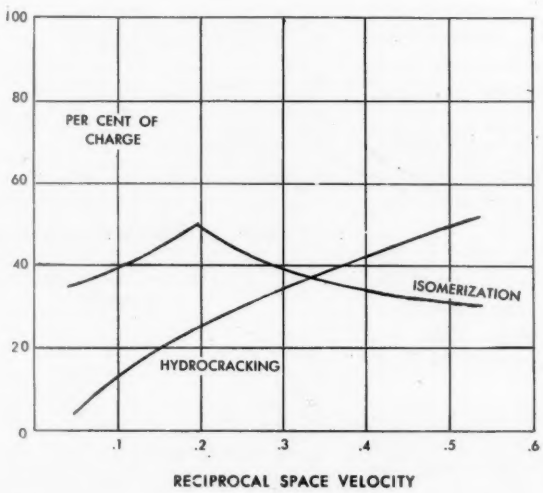
	Start	2 Mo.	4 Mo.	6 Mo.	9 Mo.
Peroxide no.	0.1	0.98	0.7	0.8	0.7
Induction period, min.	1020				
ASTM gum	0	1	0	0	1
Color °Saybolt	21	17	15	15	15

Platforming of Mixed Straight-Run Cracked Gasolines

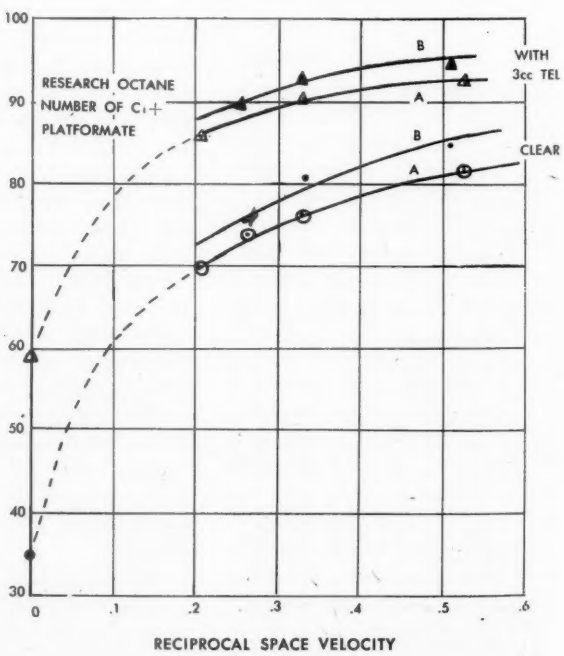
The inclusion of an olefin containing material in the charge to a Platforming unit results in the formation of a product very similar in quality to that produced from straight-run stocks alone. In view of the fact that the lower boiling fraction of thermally cracked gasoline, that is the material boiling below about 200 F, is a good fuel from the standpoint of octane number, only the higher boiling fraction of thermally cracked gasoline should be included in the charge to the Platformer. The higher boiling fraction from thermally cracked gasoline is, on the other hand, a poor fuel from the standpoint of octane number, sulfur content, and storage stability. The conversion of this fraction to a Platformate type of gasoline eliminates all these undesirable properties.

As olefin containing stocks usually cannot produce as much hydrogen as straight-run gasolines, the processing of cracked gasoline in admixture with straight-run is normally desirable from the standpoint of maintaining a

GRAPH 1.—TREATMENT OF NORMAL HEPTANE WITH PLATFORMING CATALYST IN THE PRESENCE OF HYDROGEN.



GRAPH 2.—EFFECT OF SPACE VELOCITY.



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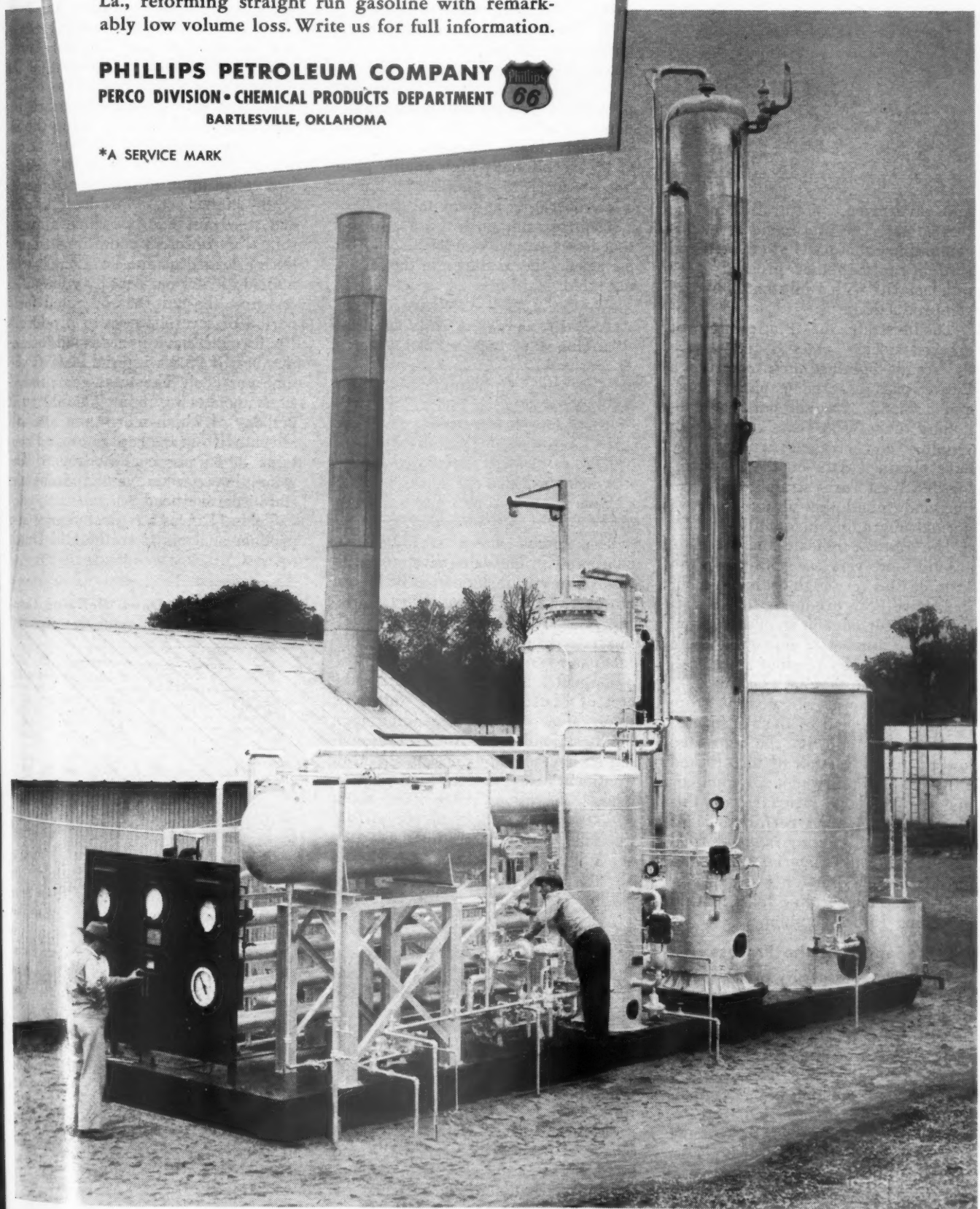

TABLE 8. Platforming cracked naphtha.

Run no.	Charge	1	2	3
Boiling range °F	275-387	133-420	117-420	106-426
Octane numbers:				
F-1 clear	60.2	74.9	79.6	89.1
F-1+3 cc. TEL	71.8	87.9	91.6	98.0
Per cent sulfur	0.49	....	....	0.0045
Bromine number	56	2	1	1

TABLE 9. Platforming of a 50:50 blend of cracked naphtha and straight-run gasoline.

Run no.	Charge	1	2	3
Boiling range, °F	102-394	108-407	105-408	88-406
Octane numbers:				
F-1 clear	55.9	78.2	84.4	89.9
F-1+3 cc. TEL	69.0	90.9	94.8	97.9
Per cent sulfur	0.33	....	0.0036	....

high hydrogen concentration in the recycle gas. The processing of blends containing equal parts of cracked and straight-run naphthas proceeds very satisfactorily with a substantial hydrogen production.

To illustrate the Platforming of cracked stocks Tables 8 and 9 give the results obtained in processing a West Texas cracked naphtha alone and a blend of equal parts of full-boiling range West Texas straight-run gasoline and cracked naphtha. We have obtained data on the Platforming of a West Texas straight-run gasoline and found that it undergoes a normal upgrading in quality.

The results indicate that thermal gasolines are very susceptible to Platforming and very high octane number fuels have been produced. The reduction in sulfur content should be of interest in a number of refineries where high sulfur crudes produce a high sulfur gasoline on thermal cracking.

We have also investigated the properties of the blend of the Platformed cracked naphtha with the untreated lower boiling fraction of the cracked gasoline. It was found upon comparing the road performance of this blend with the road performance of the original full-boiling range thermal gasoline that the material containing the Platformed fraction was superior to the thermal gasoline by a margin exceeding 15 octane numbers.

Economics of the Process

The economics of any process is of course, of major importance to the refiner. It is not the purpose of this paper to go into details of the economics of Platforming, but merely to point out the over-all picture.

The exact prediction of the economics of any proposed installation depends on an accurate forecast of the market for and the prices of both the charging stock and the product over the period of the life of the plant, which is obviously impossible. We can, however, make certain generalizations believed to be accurate:

1. The present trend to emphasize quality will continue. This will result in an increasing differential between the values of charge and of product.

2. The refiner who operates the process that can produce the highest quality product will be best able to survive in a competitive market.

3. The process that has the better yield-octane relationship will have the better economic advantage.

4. As has been shown in the data presented in an earlier section of this paper, Platforming provides for an extremely high volumetric recovery of an exceptionally high quality gasoline produced in a simple unit having a low operating and capital cost.

The operating cost of a Platformer that has a capacity of 1500-2000 bbl per stream day is shown in the following table:

TABLE 10. Operating costs for Platforming 1500-2000 BPSD charge.

	Cents per barrel reactor charge
1. Operator and part time helper per shift	4-5
2. Maintenance	3-5
3. Taxes and insurance	4-5
4. Utilities	4-5
5. Catalyst	less than 10
6. Royalty (escalator)	7
Total	30-37

The figures shown are somewhat conservative. The value given for utilities does not include the fuel gas; however, we do find that the Platforming process is normally self-supporting from the standpoint of the heaters' fuel gas requirements.

Estimates have been made for the cost of Platforming units. Naturally, these values will vary depending upon the local conditions. However, assuming an average labor cost in the Mid-Continent area and all new equipment these values range from about $700,000 for a 1500-bbl per stream day charge to reactors to $1,600,000 for a 5000-bbl per stream day charge and $2,500,000 for a charge of 10,000 bbl per stream day.

Operation of Commercial Unit

At this time it is of interest to describe briefly the progress of the first commercial Platforming unit at the Old Dutch Refining Company at Muskegon, Michigan. Fig. 1 is the simplified flow diagram of the Platforming unit, showing the prefractionator, the naphtha and recycle gas heaters, the three reactors, the separator, the compressors and the stabilizer. The unit was started on October 28, 1949, and has been in essentially continuous operation since that time, charging on the average 900-1000 bbl per stream day of a 180-360 F naphtha. More recently the throughput on the plant has been increased to about 1500 bbl a day. The performance of the plant has been highly satisfactory and, except for a few mechanical troubles, which usually accompany the first tryout of any new equipment, the operation has proved itself to be exceedingly simple. The operation has been conducted at 860-890 F average catalyst temperature and 700 psig pressure. It is interesting to note that the original plan was to operate to obtain a product with a leaded research octane number of 89-90. During the intervening period of construction, which required 139 days, the refiner was called upon to produce a considerably higher octane product. As a result, the unit has been operating at somewhat different conditions to produce a leaded octane level of 93 with a yield of 94.5 per cent by volume. At one time the unit was operated for a period of several weeks to produce a Platformate having a leaded octane number of 95.8 with yield of 90 volume per cent. The total gas production amounts to about 900,000 cu ft per day of which more than one-half is vented from the separator and contains 80-85 per cent hydrogen. The remaining gas is vented from the stabilizer overhead.

Table 11 gives a typical charge and product analysis from the Old Dutch operation:

TABLE 11. Old Dutch Refining Company Platforming operation

	Reactor charge	Product	Reactor charge	Product
Gravity API	56.9	57.6	60.0	62.1
IBP	203	88	176	86
10	220	123	192	129
50	255	240	239	215
90	300	319	302	306
E.P.	333	355	358	364
RVP	0.8	13.6	....	10.0
F-1 O.N. clear	50	86.1	49	81.3
F-1+3 cc. TEL	68.5	95.8	67.5	93.2
Sulfur	0.0450	0.0020	.....	.....

One of the most significant and important features of the Old Dutch Platforming unit operation is the performance of the catalyst. Over the past four months of operation we have found no indication of any catalyst deactivation, and we expect the catalyst to remain in service for a long time.

Acknowledgment

The development of the Platforming process is the result of intensive work on the part of many in the Universal organization and I should like to express my appreciation to my colleagues for their wholehearted cooperation.

* * *

WATER-COOLING TOWERS

HOWARD E. DEGLER†

PART 2 — TYPES AND CONSTRUCTION

THE type of water-cooling equipment used affects to a considerable extent the operating temperatures of the cooling water. Some types of equipment such as spray ponds, spray towers, and atmospheric deck towers that depend upon prevailing winds for cooling the water, must be built for low wind velocity conditions. Such equipment is not capable of maintaining a close approach to the wet-bulb air temperature, and correlated allowances must be made for good operation at all times under widely varying conditions. On the other hand, where mechanical draft equipment is employed under similar conditions, lower average operating temperatures can be obtained since a dependable approach to the wet-bulb is practicable.

†Technical Director, The Marley Company, Inc.

•Part 1, "Principles and Applications" appeared in the previous issue; and Part 3, "Operation and Maintenance" will appear in the next issue of *The Petroleum Engineer*.

Spray Ponds

The spray pond, Fig. 4, consists of a water-collecting basin, above which nozzles are located to spray the water upwards into the air. Properly designed spray nozzles break the water up into small drops, but not into a mist. Since the objective is to cool the pond water, the individual drop must be heavy enough to fall back into the pond and not float away in the air. The water surface exposed to the air passing over the pond becomes the total area of all the small drops. Louver fences to prevent the carrying of entrained water beyond the edge of a spray pond by the air on the leeward side are required for all roof locations, and for ground locations where space is restricted. Spray ponds are recommended only for large-capacity services where high efficiency in a limited area is not demanded and drift moisture is not objectionable. They are inexpensive and entirely satisfactory when correctly applied to those services to which they are applicable, although pumping requirements and basin costs are generally disproportionate with modern induced draft cooling towers.

FIG. 4. Typical spray pond installation for an oil refinery.

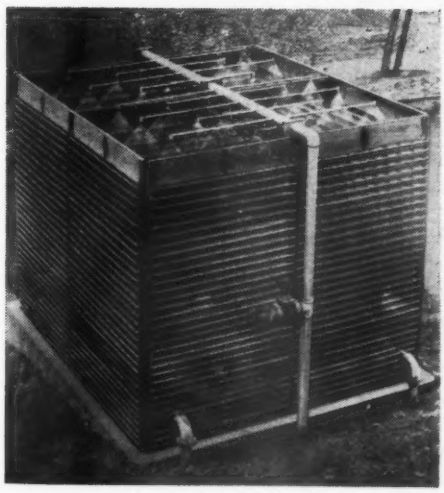

FIG. 5. Natural-draft water-cooling tower with cooling coil base for combination cooling. Note valve on supply pipe for use as winter by-pass.

Cooling Tower Definitions

A *water-cooling tower* is an enclosed device for cooling water by evaporation in contact with air. In atmospheric water-cooling equipment the heat transfer is accomplished partially by a transfer of sensible heat (about 25 per cent), which raises the wet-bulb temperature of the air; but most of the cooling is due to an exchange of latent heat (about 75 per cent) resulting from the evaporation of a small part of the circulating water. A natural draft water-cooling tower is one in which the air movement through the tower is dependent only upon atmospheric conditions. A spray-filled water-cooling tower (natural draft or mechanical) is one that is dependent solely on spray nozzles for water break-up. A deck-filled tower is one that contains baffling to increase the water break-up of the distributing system and to provide additional wetted surface. A mechanical-draft water-cooling tower is one utilizing one or more fans to move air through the tower, the fans being an integral part of the tower. A forced-draft tower is a mechanical draft tower having one or more fans located in the air stream entering the tower. An induced-draft water-cooling tower is a mechanical draft tower having one or more fans located in the air stream leaving the tower.

EXCLUSIVE

Natural-Draft Cooling Towers

For water-cooling requirements of less than 30,000 Btu per minute, the spray-filled natural-draft tower (Fig. 5) is satisfactory. The word "tower" used in this connection is a misnomer, as the design simulates a narrow spray pond with elevated nozzles and a high louver fence. As usually built, the nozzles spray downward from the top of the structure and the distance from the center of the nozzle system to the fence on either side is not more than half the distance that the nozzles are elevated above the water basin. Heights range from 6 to 15 ft, with the total width of the structure usually not greater than the height. Loadings range from 0.6 to 1.5 gpm per square feet of tower area, which means about one-fourth the area of an equivalent spray pond. The louvers are continuously wet, hence add to the surface of water exposed to the cooling air.

Drift is considerably less in a properly designed natural-draft tower than in the spray pond, but the drift nuisance may be considerable; for this reason natural-draft towers are unsuitable for downtown building roofs, locations adjacent to buildings, or near expensive mechanical equipment in industrial plants. They must be located in an open area, broadside to the prevailing wind, and are inefficient with less than 3 mph wind velocity and wind directions other than broadside. These towers are generally unattractive and since they are long and high for their width, must be securely anchored to prevent uplift or overturning during high winds. High pumping requirements and total dependence upon atmospheric caprice, especially wind (quantity and direction), are disadvantages.

Before the year 1920, large water-cooling systems were used with refinery condensing and steam-condensing operations; these plants were usually located where land was cheap enough to use spray ponds or long natural-draft cooling towers. Refrigeration and ice-making constituted the second largest outlet using both natural-draft towers and spray ponds, generally on roofs. Other markets were of minor importance.

A natural-draft tower either spray-filled or deck-filled can be used when the equipment served can stand a few degrees rise in the cold-water temperatures at low or zero wind velocities; when the drift from the tower is not objectionable to the surrounding territory; and when it can be situated so the wind will not be obstructed by buildings, trees, etc.

Since the year 1920, numerous new markets have arisen, others grown,

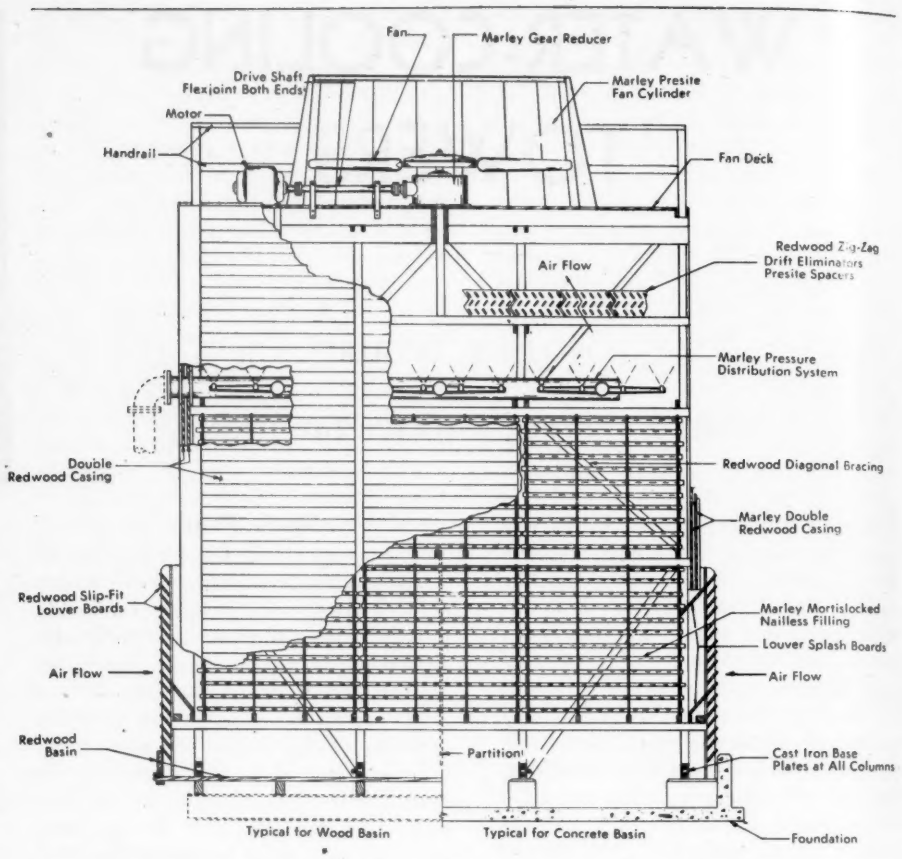

FIG. 6. Typical "Conventional" cooling tower, employs counter-flow principle (air up and water down).

and with this shift requirements have become increasingly varied and exacting, necessitating refinements and specialized adaptations of water-cooling equipment. The principal demand for large water-cooling systems in recent years has been from the petroleum industry and steam powerplants. Refrigeration, air conditioning, and engine-jacket cooling service employ a large percentage of the medium size and small towers installed today.

Mechanical Draft Towers

The mechanical-draft tower consists usually of a vertical shell constructed of wood, metal, transite, or masonry, in which water is distributed near the top uniformly over the area, and falls to the collecting basin in the bottom, passing through air which is being circulated in the tower from bottom to top by forced or induced draft fans, or horizontally in double-flow towers by induced draft fans. Since the air passes counterflow or "cross-flow" to the water, the air is in contact with the hottest water just before leaving the tower; hence a given quantity of air picks up more heat than the average equal quantity of air on natural-draft equipment. This permits the water to be cooled with the least quantity of air required by any type of cooling equipment. As movement of air through the towers is obtained by power-consuming fans, it is essential that this air quantity be reduced to a minimum so as to secure low operating cost.

The inside of a mechanical draft tower may be spray filled in which the water surface is presented to the air by filling the entire inside of the structure with water droplets from the spray nozzles, or it may be packed with wood filling over which the water cascades from top to bottom. In many cases, a combination of the spray-filled and wood-filled design is used, as shown in Fig. 6.

In the spray-filled mechanical-draft tower, the area presented to the air is the combined surface area of the small drops present in the tower at any one time. The net, free cross-sectional area of the air spaces in a spray-filled tower is greater than that of the wood-filled tower for the same plan area. This results in lower air velocities and a shorter time of contact between air and water in the same size structure for a spray-filled tower. Before discharging to the open atmosphere, the water-laden exhaust air

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passes through a drift eliminator to remove entrained unevaporated water that might be carried from the tower by air movement.

In the wood-filled tower, Fig. 6, pieces of lumber are laid horizontally across the space on as close centers, both horizontally and vertically, as required, without introducing too great a resistance to air flow. The water is distributed over the top layer by means of spray nozzles, troughs, splash heads, or through evenly spaced nozzles located in the floor of an overhead open-type water distribution basin, and drops from piece to piece of the wood filling as it progresses downward. As the air moves upward and/or across the wood filling, the latter presents a large wetted surface, repeatedly breaks up the falling drops of water, and continuously provides new drop surfaces whose integrated areas are several times that of the wood-fill area.

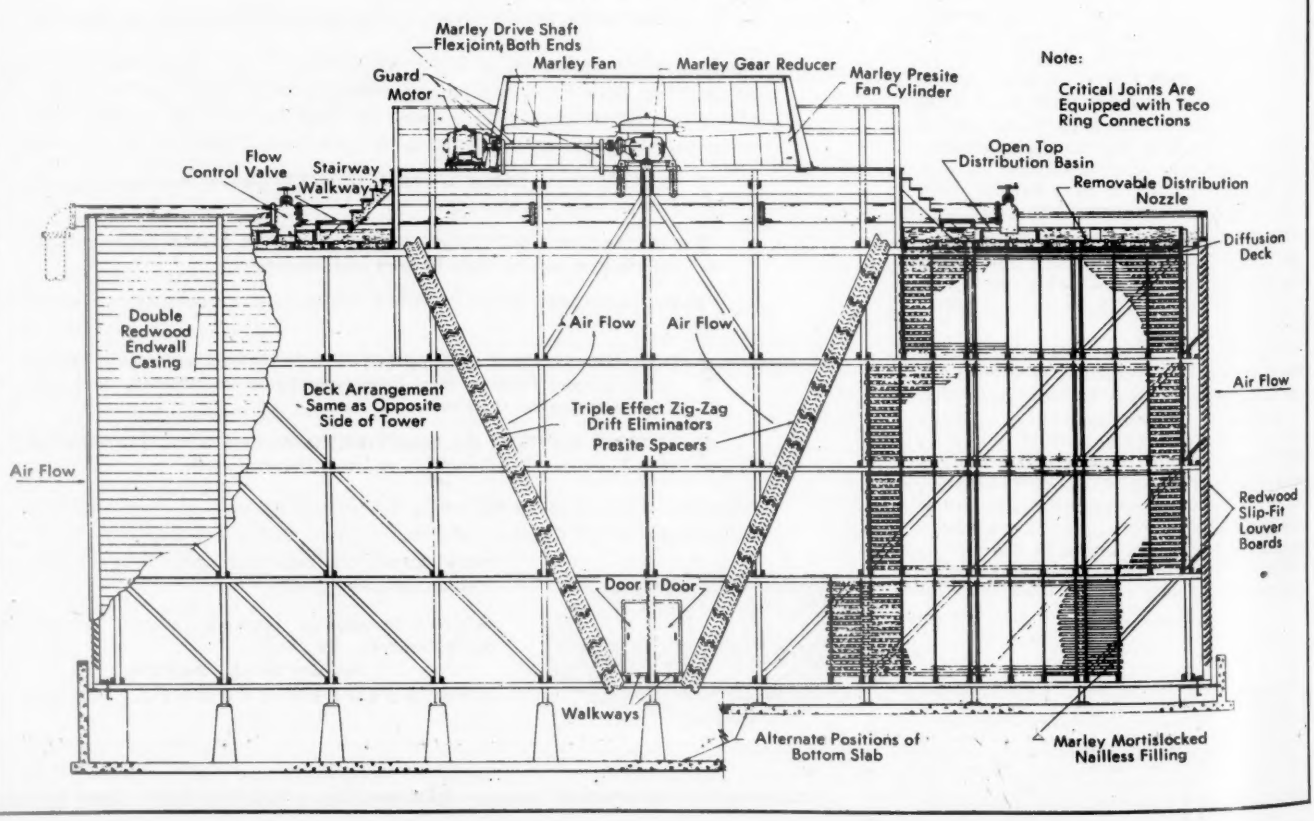
The efficiency of a mechanical-draft tower is improved by increasing the amount of filling, height, area, or air quantity. Increasing the height increases the length of time the air is in contact with the water, without affecting seriously the fan power required, but increases the pumping power. Increasing the area while maintaining constant fan power increases the air quantity somewhat and increases the time this air is in contact with the water because of lower velocity. The surface area of water in contact with the air is increased in both cases. Increasing the air quantity decreases the time the air is in contact with the water, but since a greater quantity is passing through, the average differential between the water temperature and wet-bulb temperature of the air is increased, and this speeds up the heat transfer rate. Increased air quantities are obtained only at the expense of increased fan power, which increases approximately as the cube of the air quantity. Air velocities through mechanical draft towers vary from 250 to 400 fpm over the gross area of the structure.

The performance of mechanical-draft towers is independent of wind velocity, hence it is possible to design them for more exacting performance. They require less space and less piping than atmospheric deck towers, and the pumping head varies from 11 to 26 ft, depending upon the design. Overall plant economy due to colder water temperature usually more than offsets the additional operating expense and initial cost as compared to atmospheric towers.

The forced-draft type of water-cooling tower has one or more fans located in the air entering the tower and is suitable for corrosive waters; it has the fan mounted near the ground level on a rigid foundation where it is easily accessible. Operating costs are high because of high fan-power requirements, and maintenance and depreciation both are high by modern standards. The greatest objection to the forced draft tower design is that the heated air leaves the top of the tower at a low velocity and is subject to "recirculation" to the fan inlet, this action reduces the performance and could be as much as 20 per cent. During cold weather, recirculation may cause ice formation on adjacent equipment and buildings as well as in the tower fan ring with possible resultant fan breakage. Their limited fan size (12 ft or less) means more fans, motors, starters, and wiring in larger capacities than are needed by induced draft towers that can use fans as much as 20 ft in diameter. The location of fans on top of the tower makes the induced draft type a sounder structure and minimizes the noise. It offers a neater appearance and has a ready adaptability to architectural treatment.

The counterflow (conventional) type of induced draft tower has the fan located at the top, Fig. 6, to provide vertical air movement across the

FIG. 7. Cross-flow tower with horizontal air flow (from both sides) and vertical water path; for large capacities.



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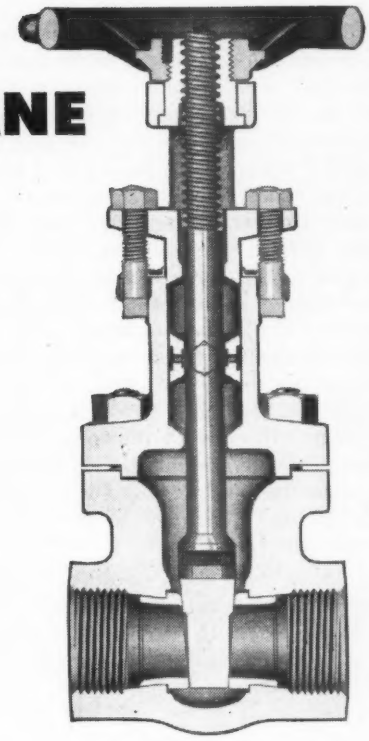

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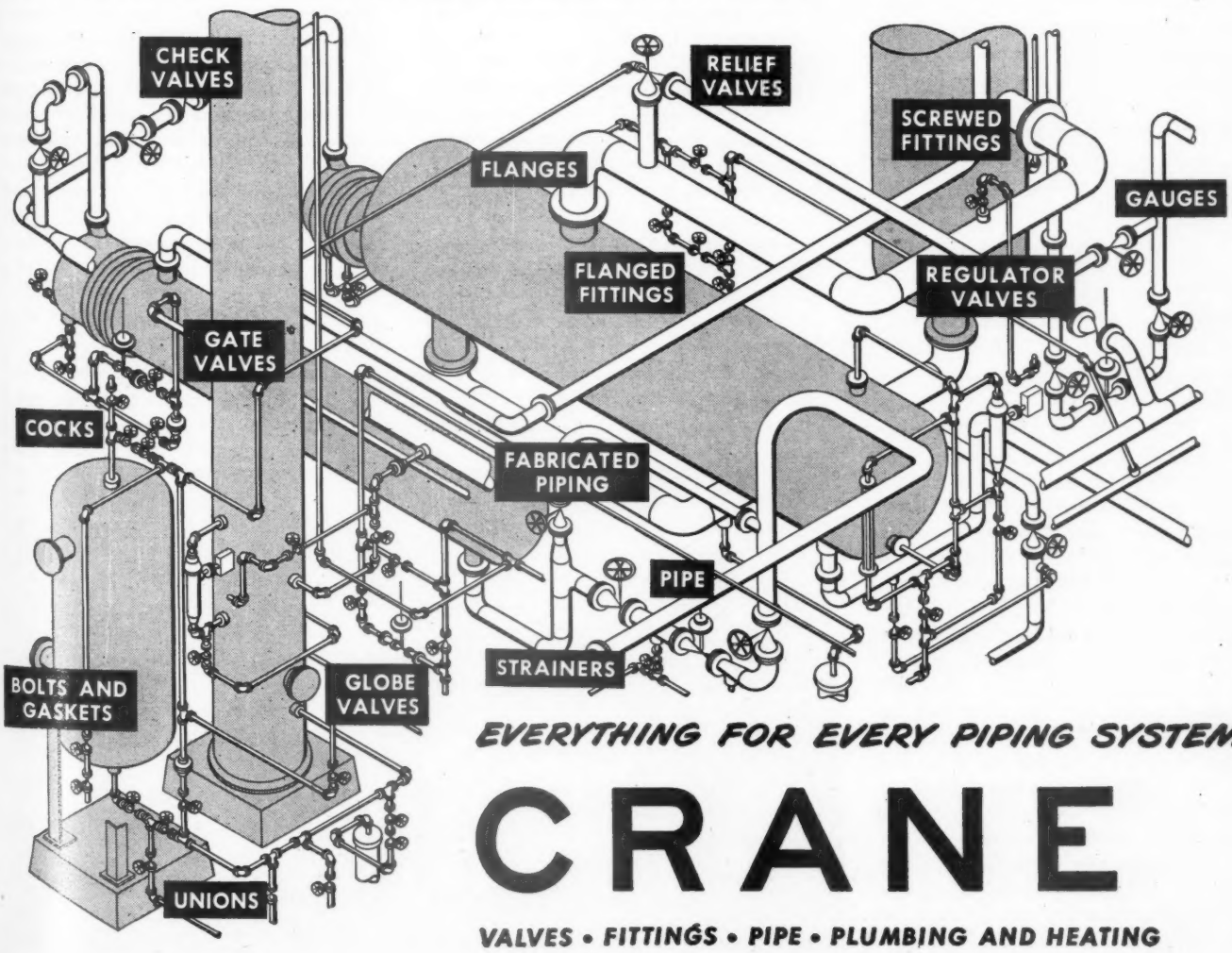

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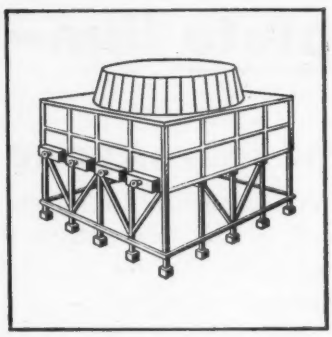
filling and discharges it upward at a high velocity to prevent recirculation. Another type (small requirements) has the induced draft fan in one end, to provide horizontal flow. During the past 10 years the demand for a more compact design, better construction, lower cost, larger capacity, more flexible operation, and improved all-around performance has produced the *double-flow* (also called cross-flow) *induced draft cooling tower*, Fig. 7. This distinctive tower employs horizontal air flow with fans centered along the top, each fan drawing air through two cells paired to a suction chamber which is partitioned midway beneath the fan and fitted with "drift eliminators" that turn the air upward toward the fan outlet.

Double-flow water-cooling towers employ a low pumping head, varying from 12 to 25 ft. Operating advantages include: Horizontal (crossflow) air movements as water falls in a cascade of small drops over the filling and across the air stream, offers less resistance to air flow, therefore a lower draft loss, has longer air travel than is practical with the conventional design, open water-distribution basin that is accessible for cleaning during operation, and has a close-space wood diffusion deck under the water basin to provide uniform water distribution to the wood filling. Most cooling tower manufacturers limit the water loading to a maximum of 6 gpm per square foot because of the blanketing effect of the spray, but heavier loadings up to 10 gpm per square foot are possible in double-flow towers. A modern double-flow water-cooling tower occupies less than one-twentieth of the area required by a spray pond for equivalent service.

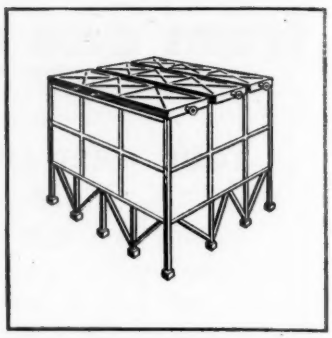
Finned-tube Dry-Cooling Unit

A finned-tube dry-cooling unit is a device for cooling or condensing fluids by circulating them (gases or liquids) through finned tubes and forcing or inducing atmospheric air across the coil sections; it is basically a non-contact convection-type heat exchanger. In large units, the most common arrangement of fan and coils is the induced draft unit (Figs. 8 and 9) with the fan mounted on top discharging the air upward and inducing air through a horizontal bank of coils, mounted below the fan. Another arrangement is the forced draft unit shown in Fig. 8 with the fan discharging air vertically upward through a horizontal bank of coils mounted above the fan. Small portable units are conventionally arranged with a vertical coil bank mounted to receive a horizontal stream of air through the coil.

FIG. 8.



Induced draft dry-cooling unit, heat-transfer surface under fan.



Forced draft dry-cooling unit, heat-transfer surface above fan.

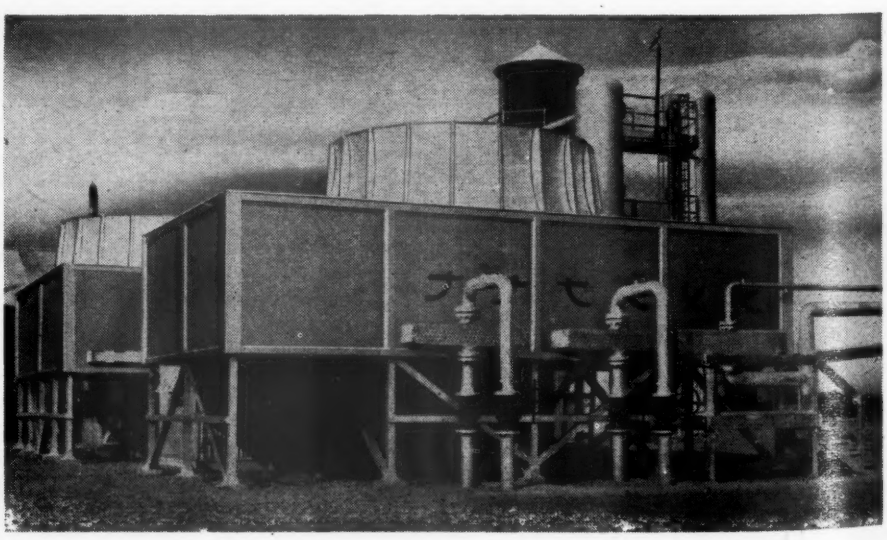
The dry-cooling unit may be used in preference to a water-cooling tower for applications where temperatures of the fluids to be cooled are high (above 130 F when referred to a 100 F dry-bulb design air temperature), where water is scarce, expensive, and/or badly polluted, or where the portable features of a dry-cooler would be desirable. Normally the cooling tower is more economical, but the cost of the dry-cooler decreases relative to that of the tower as the temperatures of the fluids to be cooled rise. Both units have their own applications but in some instances either type may be used. However, a careful evaluation of both methods should be made to insure that the most suitable equipment is used for each application.

When estimating the design air temperature for dry cooling, it is normally acceptable to choose a temperature which will not occur more than 10 per cent of the hours between noon and midnight during the months of June to September, inclusive. The temperatures which occur in excess of this value will be of such short duration as to not have an appreciable effect on efficiency or performance.

The diameter of the tube coils is determined largely on the basis of anticipation of possible scale formation. Where scaling conditions may be encountered, the larger diameter tubes are preferred, however, this consideration is offset by the lower first cost and better efficiency of small diameter tubes. The low limit in tube diameter is $\frac{5}{8}$ in.

Operation and maintenance of water-cooling equipment will be presented in the next issue of *The Petroleum Engineer*. * * *

FIG. 9. Dry-cooling unit at gas compressor station cools 20,000,000 cu ft natural gas per day, from 185 F to 100 F (80 F air) in 2 coils on left; coil on right cools regeneration gas.



PART 2—THE PRELIMINARY ESTIMATE

How to Estimate Plant Construction Costs

GEORGE E. BROOKS

In Part 1 of "How to Estimate Plant Construction Costs," (Page C-7 in our March issue) the author outlined in detail the fundamentals of the increasingly important field of estimating costs of any proposed manufacturing unit, and the requirements for the making of such estimates. He shows the nature and types of facts needed to start work on an estimate —knowledge of the process of manufacture, equipment required to carry it out, flowchart of the operation, knowledge of climatic conditions obtaining at the unit site; quality and training of personnel available to handle the unit or plant. The estimator must know details and principles of construction methods, foundations required, and especially will need to have had previous estimation calculation making experience.

This Part 2 discusses the Preliminary Estimate and the routine of preparing it. What consideration should be given to unit flexibility, what limitations are placed on the estimate by land space available. The estimator must know how the new unit will fit into existing processes; how to utilize the various engineering cost indexes, and then takes up the detailed system by which each item is studied and its approximate cost is arrived at. This Preliminary Estimate is needed generally when approval of plan to go ahead with the preparations for construction of a given unit is required from top executives. Part 3, which discusses the more exacting Check Estimate, will appear in an early issue.

In article 1 of this series the fundamentals of estimating were outlined and a general indication of how these fundamentals were to be applied was given. Mention was made of the rough or preliminary estimate and it is with this type of estimate that this article will deal.

When two or more possible processes have indicated their suitability as to the manufacture of a given product, the question arises as to which should be selected. This question can be answered when the capital investment required for each is available, and the anticipated annual return on the investment can be calculated.

Since detailed engineering studies of each process are necessary before bids can be secured from firms building the types of plants to be chosen between, it is essential that some means of approximating the cost of each be available. Accuracy need only be such that large errors are eliminated. The object at this point being to decide on the most attractive proposition. A detailed cost breakdown is not therefore usually required.

The first step is to obtain flow diagrams of each process and lay out roughly a tentative plot plan for each. Flexibility of operations may dictate two or more small units rather than one large one. Then again the possibility of future expansion may influence the layout. Where land is at a premium compactness is important, but fire hazards must also be considered. Next the preliminary plot plan should be superimposed on maps of the existing plant where the new construction is to take place. This will aid greatly when the time comes to estimate the cost of additional utilities required by the added capacity. It will also serve to give a picture of how the new equipment will fit into existing manufacturing facilities, and may suggest some ideas as to how existing lines, tanks, pumps, etc. may be utilized to serve the new unit as well as the old units by certain switches in service or location. It should be kept in mind at this point that there are three kinds of new construction to be considered. These are first, expansion of existing facilities, second, new facilities in an existing plant, which consist of additional new buildings and equipment but utilizing present plant services, and third, entirely new construction at a new site. The relative costs of added capacity provided in each of the three ways listed above, basing the second type at a value of 100 are roughly 86 for the first type and 136 for the third type. It is apparent, therefore, that wherever possible existing facilities should be expanded to keep construction costs at a minimum unless technological developments have outmoded present equipment or methods.

Before plunging into the actual estimating of the plant cost desired, a review of the available cost data should be undertaken. If the cost data is to be used with any degree of confidence as to its reliability, it must either be of very recent vintage or some means of bringing it up to date must be employed. Costs in general vary pretty well in accordance with business cycles but specific items of equipment may vary in greater or less degree according to the class of material or type of labor used in their production. Other factors that affect costs on individual items are competitive conditions in the industry, the relation of backlog of orders to production capacity, labor efficiency, and the general business outlook for the industry involved. The answer to this problem, of course, is an index of cost variations over a span of years.

Many indexes relating to equipment costs are available in the monthly Survey of Current Business published by the U. S. Department of Commerce. Wage rates in various industries and according to labor groups are also furnished by the same agency. A number of other indexes are published by private concerns pertaining to the fields in which they are interested. Unfortunately no one index will be found that exactly fits the process or oil industry. The elements of labor and material are included in many indexes but not in the proportions found in the particular field in which we are interested. For general construction such as buildings, roads, dams, and such several indexes are published currently. One of these is the Engineering News Record Index of Construction Costs. This index has the advantage that it is available back as far as 1913

EXCLUSIVE

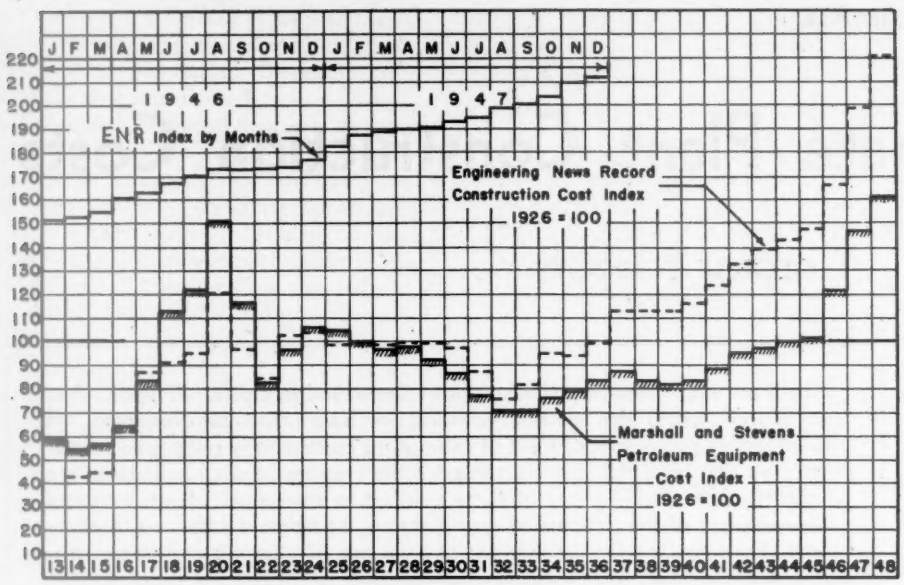

J F M A M J J A S O N D J F M A M J J A S O N D
1946
1947
ENR Index by Months
Engineering News Record
Construction Cost Index
1926 = 100
Marshall and Stevens
Petroleum Equipment
Cost Index
1926 = 100
YEAR

FIG. 5

with the cost of a block of construction in that year taken as $100. It has another advantage in that it can be converted to a basis of 100 in any other year desired by direct ratio of the index in the year desired to the base year. The index contains both elements of material and labor and is published monthly. The material portion of the index is based on the price of 2500 lb of steel, 6 bbl of cement, 1088 board feet of lumber, and the labor portion on the cost of 200 man-hours of common labor. At first glance this does not seem to be very representative of costs for process or chemical plants, nevertheless, it is used widely with considerable success in adjusting costs of such plants to present conditions when a cost at an earlier date is known. As the index is not corrected for productivity, it will tend to be higher than actual costs when productivity is high and lower when productivity is low. During periods of normal productivity the index should reflect actual cost changes closely. By estimating productivity today as compared to the time of some project where actual costs are available, a correction may be applied in accordance with the judgment of the estimator to compensate for the lack of such adjustment in the preparation of the index as published. Such an adjustment will probably vary for each type of job being estimated.

Another index that would seem to more closely approximate trends in the petroleum field is the Marshall and Stevens Petroleum Equipment Cost Index for the Petroleum Industry that is based not upon the cost, periodically reported, of a certain machine or group of machines utilized in the industry, but upon detailed equipment appraisals made by the Marshall and Stevens Company of Chicago and others over the years, back as far as 1919. This firm of valuation engineers also issues quarterly index numbers for comparative equipment costs for 47 different industries and commercial ventures which are available to the firm's subscribers.

For convenience in comparing the two indexes mentioned in the preceding paragraphs, they have been plotted on the same chart with each having a value of 100 in 1926. Refer to Fig. 5. In addition, a monthly tabulation of the ENR Index is shown for the years 1946 and 1947. This latter plot clearly emphasizes the rapid and almost unpredictable rise in construction costs following the recent war. During 1948 the index reached a peak of 231 in October and started to fall slightly only to reverse itself and return at the present time to the peak reached a year ago. Even with up-to-date prices and an accurate index it is apparent that predicting future costs will still lie in the realm of judgment of the estimator. The actual construction of a project usually does not take place until 6 months to 2 years after an estimate of cost has been prepared. From the first of 1946 to the end of 1947 the index rose 60 points, or roughly 40 per cent. With that as a criterion an estimator preparing an estimate in the early part of 1948 might allow an extra 40 per cent to his costs for a project lasting through 1949. The fact that the index today is practically the same as it was a year ago shows the fallacy of going overboard on any index. The index should be used only as a guide to determine today's cost and then whatever adjustment is felt to be necessary should be made with extreme caution.

Referring to the curves of the two indexes, it will be noted that prior to 1926 the Petroleum Equipment Index ran ahead of the ENR Construction Index, but during the depression years they ran along pretty well together with the Equipment Index lagging behind. After the bottom was reached the Construction Index forged ahead and has remained there ever since. Somewhere between these two there lies an index, not yet developed, which will be acceptable to the majority as typical of the Petroleum Industry. It could very well be a composite of these two properly weighted and adjusted for factors peculiar to the industry. Lacking such an index, we will string along with the ENR Index for the purpose of this discussion, as it is close enough for determining relative costs over short periods of time. Both curves give cost adjustments within the limits of accuracy desired in a preliminary estimate.

To demonstrate more clearly the foregoing discussion of predicting approximate plant costs it might be well at this point to work out a sample problem. Let us assume that at a particular oil refinery it has been demonstrated that increased profits can be realized if more crude can be run. It will be assumed that this plant is not at present equipped for vacuum distillation but the addition of such a unit is also desirable for balanced operations. The new vacuum unit appears profitable when charging stock from existing units as well as the proposed new crude unit. An examination of the crude supply situation reveals that it may be necessary to run sour crude on the new units and therefore adequate corrosion protection should be provided on this equipment. The problem boils down, then, to the erection of a new two stage crude unit with a capacity of 10,000 bbl per operating day on the atmospheric section and 9500 BPOD on the vacuum section.

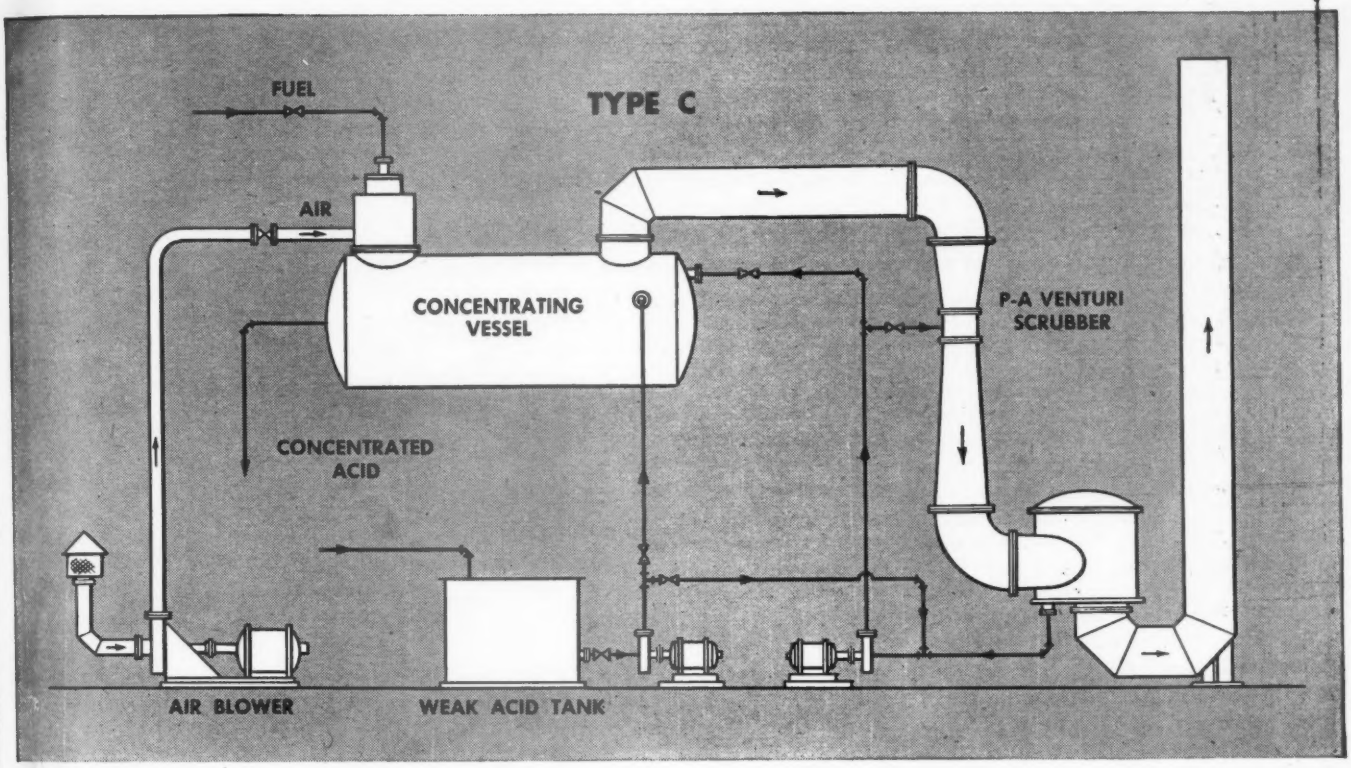
The solution of this problem is shown in the accompanying reproduction of the estimate of cost sheet in Fig. 6.

Taking the Atmospheric section first, the known cost of a present unit at Plant "A" was adjusted by use of the ENR index to today's cost. To compensate for the difference in size between the old unit and the proposed new unit the quantities handled by each were next studied. Comparing the

Chemico Announces

NEW HIGH TEMPERATURE CONCENTRATOR

for spent sulfuric and phosphoric acids



THE NEW TYPE C High Temperature Acid Concentrator is a major improvement on the well known Chemico Drum Type Concentrator. This new unit is specially designed for concentrating spent sulfuric acid from petroleum refining, alcohol synthesis and nitrating operations as well as phosphoric acid from triple superphosphate operations.

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3. Low initial investment.
4. Low operating cost.
5. Low maintenance cost.
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7. High acid recovery.
8. Built-in fume eliminator (P-A Venturi Scrubber).
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FIG. 6

ESTIMATE OF COST

EST. NO. _____ SHEET NO. 1 of 2
ENG'R'S. EST. _____

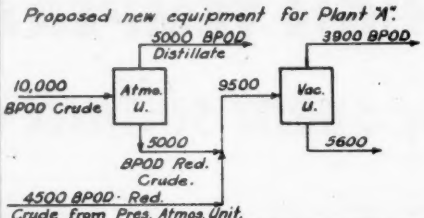
PROPOSED ADDITIONAL CRUDE CAPACITY WITH SOUR CRUDE CORROSION PROTECTION

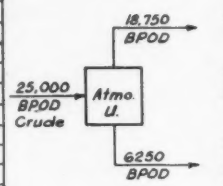
PLANT NAME Plant "A"
DWG. NO'S. _____ COMPUTED BY GEB DATE July 19, 1949

ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
Atmos. Section	10,000 Bbl.						$ 935000
Vac. Section	9,500 Bbl.						$ 1515000
Sub Total							$ 2,450,000
Corr. Protect Atm.	15%						$ 140000
Corr. Protect Vac.	15%						228000
Depropanizer (L.S.R. only)							250000
Sub Total - Corr. Protection							$ 618000
Total Cost Main Units.							$ 3,068,000
Utility Requirements							
Steam Lines	35,000 #/hr.						$ 105000
Cooling Water	6000 gpm.						300000
Barometric Water	4000 gpm.						160000
Additional Power Distrib.							25000
Additional Air Supply							15000
Rundown Tankage	None Additional Req.						—
Storage Tankage	None Additional Req.						—
Revamp Field Lines							10000
Clear Site							317000
Misc. & Constr. Incidentals 15%							600000
Total Estimated cost - Added crude capacity.							$ 4,600,000

CALCULATION SHEET

Proposed new equipment for Plant "A".





Existing Atmos. Unit cost $920,000 in 1940. ENR 116. Todays index 229.5.

$\frac{229.5}{116} \times 920{,}000 = \$1{,}815{,}000$. Todays cost of existing unit.

Basis overhead products Ratio.

$\frac{5000}{18{,}750} = .267 \quad (.267)^{.6} = .45$

$.45 \times 1{,}815{,}000 = \$817{,}500.$

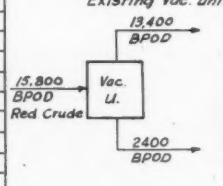
Basis charge rate.

$\frac{10{,}000}{25{,}000} = .40 \quad (.40)^{.6} = .58$

$.58 \times 1{,}815{,}000 = \$1{,}052{,}500$

$1{,}870{,}000$

Ave. = $ 935,000



Existing Vac. unit at Plant "B" cost $1,445,000 in 1942. ENR 133.

Todays cost = $\frac{229.5}{133} \times 1{,}445{,}000 = \$2{,}495{,}000.$

Basis overhead products Ratio.

$\frac{3900}{13{,}400} = .291 \quad (.291)^{.6} = .475$

$.475 \times 2{,}495{,}000 = \$1{,}185{,}000.$

Basis charge rate.

$\frac{9500}{15{,}800} = .601 \quad (.601)^{.6} = .74$

$.74 \times 2{,}495{,}000 = \$1{,}845{,}000$

$3{,}030{,}000$

Ave. = $ 1,515,000

per cent of overhead product expected from the new unit with that currently being produced from the present unit it will be seen that the new unit will have relatively less overhead production and consequently relatively less condensing equipment and probably a smaller tower and heater than would be indicated by a comparison of the charge rates. To take into account this variation in design, the cost of the new unit was calculated two ways. One way used the ratio of the charge rates to the 6/10th power and the other used the ratio of the overhead production rates. The same exponent was used in each case as previous experience had shown that this type of unit followed that exponent within reasonable limits. The two values thus obtained were averaged to predict the cost of the new atmospheric section of the new two-stage unit. Since no vacuum unit was in use at Plant "A," the cost of a vacu-

FIG. 7

ESTIMATE OF COST

EST. NO. _____ SHEET NO. 2 of 2
ENG'R'S. EST. _____

ADDITIONAL OPERATING FACILITIES BECAUSE OF RUNNING SOUR CRUDE

PLANT NAME _____
DWG. NO'S. _____ COMPUTED BY _____ DATE _____

ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
Solv. Rfg. Unit							1065000
Gasoline Trtr.							630000
H_2S Unit							219000
Total Operating Units							$ 1914.000
Utilities							
Steam Generation							176.000
Steam Distribution							125000
Cooling Water							120000
Plant Air							25000
Electric Power							15000
Tankage							150000
Field Line Changes							15000
Clear Site							460000
Misc. & Constr. Incids							450000
Total Estimated Cost This Section							$ 3,450,000
Previous Cost of Additional Crude Capacity							4,600,000
Total Cost of Project							$ 8,050,000

CALCULATION SHEET

Proposed solv. Refg. unit.
Oil + solv. charge 9000 BPOD.
Existing unit "A" charge 5000 BPOD cost $1,300,000
Existing unit "B" charge 16000 BPOD cost $2,100,000
Charge ratio $\frac{9}{A}\ \frac{16}{15} = 3.2$ Cost Ratio $2\frac{1}{1.3} = 1.615$
∴ Exponent 0.4
Cost of proposed unit.
Charge ratio $\frac{9000}{5000} = 0.6 \quad (.6)^{.4} = .82$
$.82 \times 1{,}300{,}000 = \$1{,}065{,}000$

Proposed Gasoline Treating Unit 6000 BPOD ENR 229.5
Existing unit 9000 BPOD @ Plant B" cost $606,000 ENR 188
cost today $\frac{229.5}{188} \times 606{,}000 = \$741{,}000$
size ratio $\frac{6000}{9000} = .667$; $(.667)^{.45} = .85$ cost ratio
Cost of proposed unit $.85 \times 741{,}000 = \$630{,}000$

H_2S Removal Unit 100 BPH Proposed ENR 229.5
Existing unit "A" 154 BPH cost $330,000 ENR 229.5
Existing unit "B" 42 BPH cost 94,000 ENR 229.5
Unit "A" cost/bbl charge $\frac{330{,}000}{154} = \$2140/bbl.$
Unit "B" cost/bbl charge $\frac{94{,}000}{42} = \$2240/bbl.$

Since new unit lies approximately ½ between existing unit charge rate, and exponent is nearly unity, use ave/bbl. cost of $ 2190 x 100 = $ 219,000.

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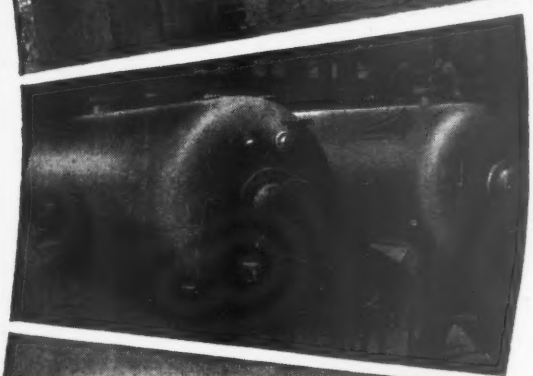

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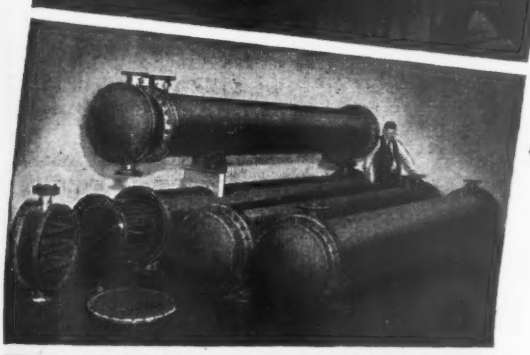

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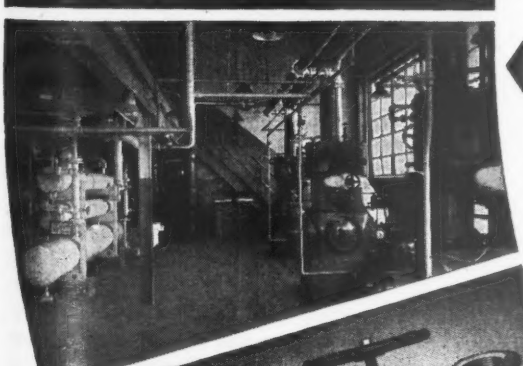

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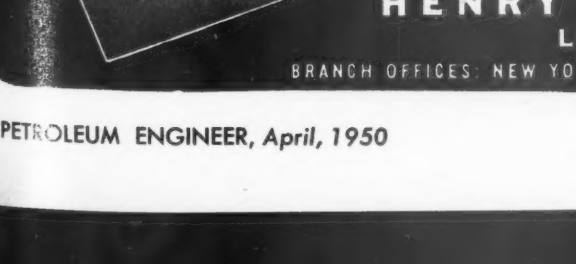

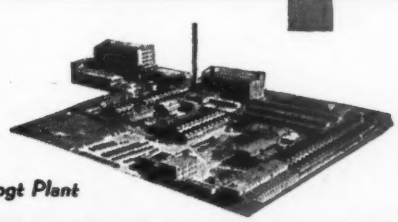

Air View of Vogt Plant

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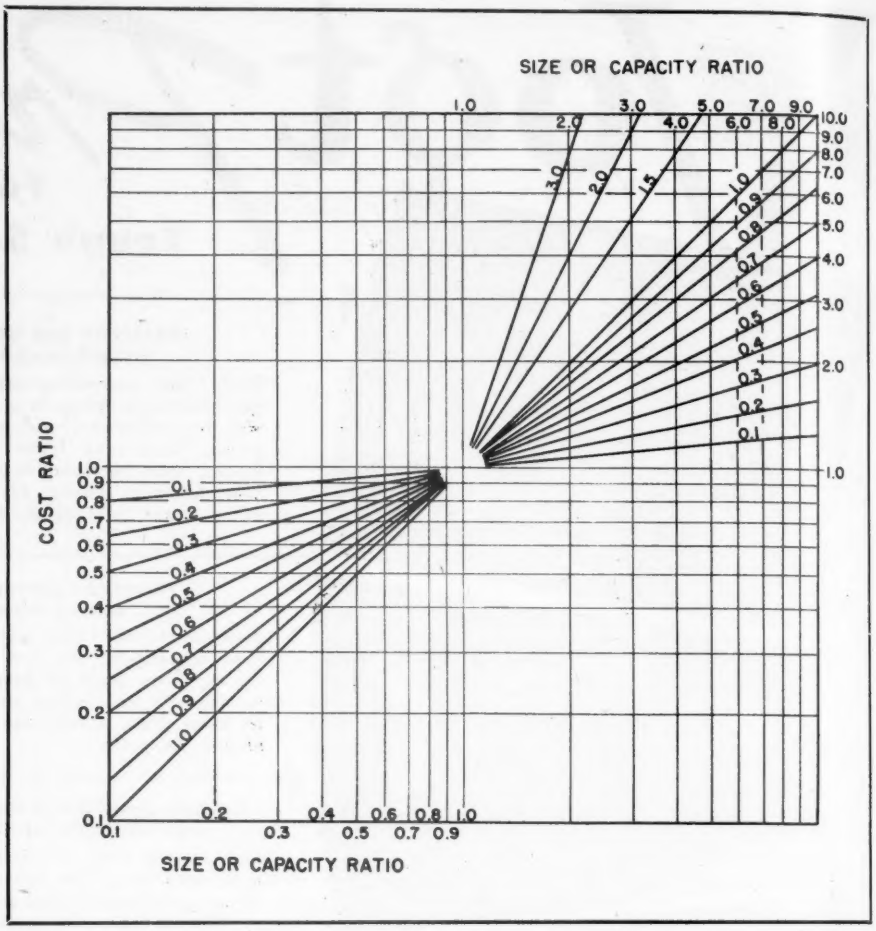


FIG. 8

um unit at another plant "B" erected at a different time was used to determine the cost of this section. The same procedure was followed here as for the atmospheric section for the same reasons.

As the possibility of having to run sour crude on the new unit had been suggested, the allowance for alloy protection was calculated as a separate item. Keeping this cost isolated may prove advantageous when the question comes up as to how much of a penalty is being paid for having to run sour crude, or to put it another way, what savings could be made if sweet crude were available. The arbitrary addition of 15 per cent to each section of the crude unit was the result of comparing costs on existing units with and without corrosion protection. The Depropanizer shown was deemed necessary by previous experience to remove H_2S, and its cost was taken directly from data on this type of equipment. Its cost was included along with alloy corrosion protection since the availability of sweet crude would also remove it from the picture.

A survey of existing steam generating equipment showed ample capacity but lack of adequate distribution lines. The cost per pound of new lines was based on the cost of the existing system divided by its carrying capacity and adjusted to the comparable cost today by the ENR Index. The cost of providing the additional cooling water needed was based on the cost of providing the same capacity at another plant during a recent construction program. The same is true of the barometric condenser water supply system. The quantity of additional utilities required was based on the known demands of present equipment. Present tankage was found to be adequate without addition, but in order to erect the new unit at the desired site, it was necessary to relocate some of the tanks and revamp the lines serving these tanks and some others for the new setup. The cost of clearing the site was based on available data on the cost of relocating tanks and other obstructions involved. The items of miscellaneous and construction incidentals were also based on previous experience on this type of project.

It is now safe to predict that the cost of the proposed new capacity will lie between $4,000,000 and $5,000,000 and that $4,600,000 is a fair figure to use for the investment required when

ESTIMATE OF COST

EST. NO. _____ SHEET NO. 1 of 1
ENG'R'S. EST. _____

LIGHT OIL TREATING UNITS
PRELIMINARY COST

PLANT NAME Plant "M"
DWG. NO'S. _____ COMPUTED BY GEB DATE Oct. 11, 1949

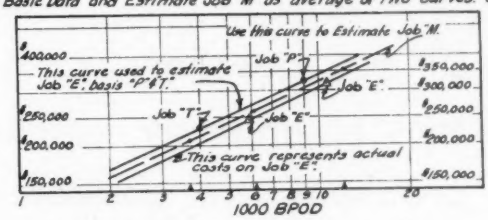
ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
		45%			55%		
Treating Unit	12,000 BPOD	$160000				$197000	
Treating Unit	6100 BPOD	119000				146000	
Treating Unit	3700 BPOD	95000				115000	
Total Est. Cost		$374,000				$458,000	$832,000
(Including Contract Charges)							

CALCULATION SHEET

REQUIRED:
Treating unit for 12000 BPOD.
Treating unit for 6100 BPOD.
Treating unit for 3700 BPOD.

BASIC DATA:
Job "T" Treating Unit for 4000 BPOD cost $232,000. } Rev. to 1949
Job "P" Treating Unit for 9000 BPOD cost $331,000. }
Job "E" currently being completed.
10,600 BPOD Unit Estimated @ $357,000. Actual $323,000.
5,900 BPOD Unit Estimated @ $274,000. Actual $248,000.
Estimated costs on Job "E" based on data from Jobs "T" & "P". Actual costs on Job "E" based on field cost report at 90% completion.

SOLUTION:
Plot Basic Data and Estimate Job "M" as average of two curves. See below



MATERIAL AND LABOR DISTRIBUTION:
Basis average ratio of Material Cost to Total Cost on Jobs "P", "T", & "E". Material on Job "M" should run 45% of Total Cost taken from above curve.

	Total		Mat'l.	Labor
12000 BPOD	$357,000	x 45% =	$160,000	$197,000
6100 BPOD	265,000	x 45% =	$119,000	$146,000
3700 BPOD	210,000	x 45% =	$95,000	$115,000

FIG. 9

calculating anticipated returns to be realized. If sweet crude can be obtained a saving in initial investment of roughly $700,000 ($618,000 plus 15 per cent) can be effected.

If this preliminary estimate of the cost of providing increased crude capacity meets with favorable action by the management and it is decided to carry the project further assuming sour crude to be run, the next problem is to find out what other operating units will require modification. First of all it was determined that to meet specifications on one product, solvent refining would be necessary. Next it was found that additional gasoline treating would be needed and that to prolong catalyst life on another unit it would be necessary to remove the H_2S from the charge to that unit.

Determination of the added cost for these changes is shown on Page 2 of the estimate of cost (Fig. 7).

For the solvent refining unit the exponent of 0.4 was found easily enough by use of the chart shown in Fig. 8 and used to ratio the cost of the new unit from available costs on other installations of different size. The exponent for the gasoline treater was found to be 0.45 but a surprise was due when it came to the H_2S unit. Here the cost seems to vary in a straight line ratio. This trend was checked further against several other costs for units of the same type and capacity range and found to be true within the limits of accuracy desired.

When it came to rechecking the utilities, however, it was found that existing steam generating capacity was no longer adequate. New generating capacity as well as distribution facilities were required. The remaining items are pretty familiar by now and need no further comment. The total cost of the project will be found to have nearly doubled since the decision to go ahead on the basis of sour crude running was given after the first preliminary estimate. In view of these later developments the project may no longer be attractive. If the decision is still favorable, the next question probably will be how soon can the work be completed. To get at the answer to that question it is necessary to have some split between material and labor for all the items previously estimated in lump sums. This can be done accurately enough for preliminary purposes by going back to the known cost data on which the estimate was based and using the same ratio of labor to material as existed in the original job. When the total labor figure has thus been determined, it should be corrected for any contacting costs, royalties, etc., that may have been included under labor in the original job. After these costs have been deducted a base labor figure is available. By dividing this figure by an estimated average labor rate for the job the total man-hours required will be known. From the total man-hours required and an estimate of the number of men that can be expected to be employed efficiently the construction time can be roughed out. Allowance should be made for delays on account of bad weather or irregular receipt of materials. Next a spot check on the major items of equipment can be made by phone to get approximate delivery dates. The estimator then is in a position to make a stab at predicting when the proposed new facilities can be expected to go into service.

Another example of how a preliminary estimate may be prepared is illustrated in Fig. 9. In this case it was desired to provide an existing plant with additional light oil treating facilities. Three separate units were proposed, varying in size from 12,000 bbl per operating day down to 3700 BPOD. Data on several other similar projects were available as a guide and by comparing the estimated costs for these units with the final actual costs a curve of most probable costs for the proposed units was developed. This curve was then used to predict the cost of the new units in question.

Costs for job E were known to have been estimated from actual costs on jobs P and T. Actual costs on job E fell roughly 10 per cent below what had been estimated. Sufficient time was not available to make a complete analysis of costs on these jobs to find where the discrepancy occurred. As a compromise, a new curve was drawn between the other two curves. Full advantage was not taken, therefore of the 10 per cent savings indicated by the data. For the purpose of a preliminary estimate, which is fundamentally speed of obtaining an approximate cost, further refinement was not justified. In the next article of this series the summary sheets for two of these units will be shown detailing the cost breakdown as obtained in the check estimate. They will substantiate the above reasoning. ***

THE TECHNICAL FORUM

Difficult questions on petroleum and natural gas industry's technology, chemistry, engineering, and operating problems are answered each month in this Forum by the most outstanding technical authorities in the world.

Asphalt Manufacture

Q We are intending to commence in the near future the manufacture of blown (roofing) asphalts. Approximately how many cubic feet per minute of air is needed per ton of oil being blown? Is there danger of flashback of the air and gas-oil vapor mixture into the blowing still; and if so, what precautions and safety measures should be taken to prevent this? How may the gas-oil vapors be condensed and thus be prevented from becoming a community nuisance?—K. L. W.

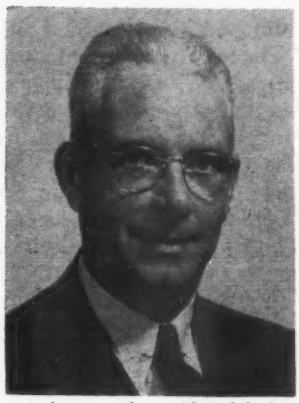
A There are so many factors that influence the production of blown asphalts that there is little general data that could be applied directly for any one particular application. As a basic factor, the characteristics of the asphalt stocks are of great importance and, in most instances, considerable experimental work is required to establish the optimum processing conditions for each asphaltic stock. In addition to the nature of the asphalt being processed, there are many other factors that influence the rate of oxidation and all of these must be considered in the design of facilities for this type of operation. The more important variables involved are the temperature, air rate, blowing time, and depth of asphalt in the still. All of these variables are inter-dependent and in commercial practice, all except one factor is usually fixed to simplify the control of the process. Air rates of 30 to 50 cu ft per minute per ton of asphalt are most generally used in commercial units with temperatures ranging from about 475 F to 575 F. Under these conditions, the blowing time required will vary greatly depending upon the characteristics of the asphalt and the reduction in penetration desired.

In asphalt oxidizing stills, a fire hazard is always present, since the oxidation reaction itself is essentially the controlled burning of the asphalt to increase the carbon/hydrogen ratio in the residue. This reaction generates substantial quantities of heat and unless the operation is rather carefully controlled, the mixture can overheat and flash. To take care of conditions of this sort, explosion hatches are generally provided in the stills and steam snuff lines are connected to the vapor section of the still. The importance of proper temperature control cannot be over-emphasized and many units provide internal or external heat exchangers to adjust the temperature of the asphalt to the proper level prior to oxidation and to remove the heat generated during the course of the blowing operation.

Most commercial units make some provision for scrubbing or burning the effluent vapors from the oxidizing stills. These vapors generally have a very unpleasant odor and can be quite a nuisance unless properly controlled. Furthermore, depending upon the amount of volatile matter in the charge to the still, there is frequently a sufficient quantity of oil in the vapors to warrant some type of recovery system. The most commonly used scheme is the installation of a countercurrent water scrubber for the vapors leaving the still. The water rate to the scrubber is adjusted to cool the vapors to a point where substantially all of the oil vapor is condensed; most of the odoriferous constituents are also removed under these conditions. Although the oil and water from the scrubber may tend to emulsify, it is still generally possible by proper settling and demulsification to recover the oil for use as cracking stock.

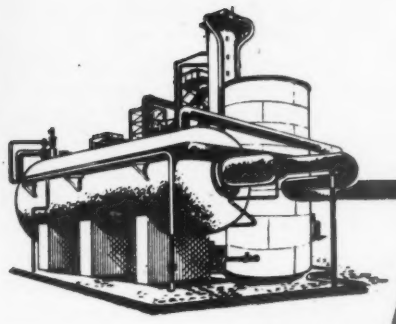
Where recovery of the oil vapors cannot be justified and particularly in congested areas, the still vapors are burned by passing them through a fire box designed for this purpose. Fume

Vincent E. Bowes Joins Technical Panel



Native of New York City, Vincent E. Bowes is manager of Oakite's Petroleum Service Division. With a long background in manufacturing gas plants, he had, following World War I in which he was Engineer Officer in charge of fuels and lubricants logistics, specialized in purification methods for gases. He was successful in developing some processes for the improvement of heat exchange efficiencies and problems dealing with the use of petroleum oils in manufacturing gas. Six years ago he was placed on the study of problems dealing with heat transfer, cleaning and maintenance methods for the refining and allied branches of the industry. Later made manager of the Division, he now correlates all the activities of the company in the petroleum and associated industries. He is an active member of the API and an ardent golfer, spending most of his few leisure hours "just this side of par."

Bowes will specialize in answering questions relating to cleaning and conditioning methods in the refining and other divisions of the industry.



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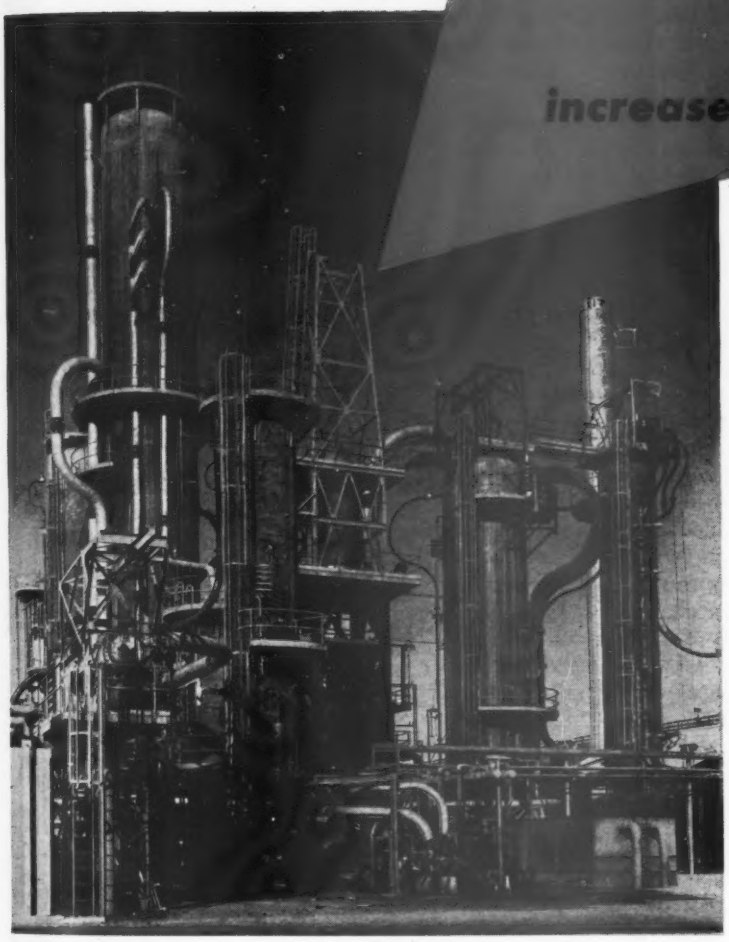

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burning completely removes all of the oil and eliminates all odors; however, the costs of installation and operation are generally greater than those for the scrubber.

To supply the variety of oxidized products demanded by the present asphalt market, the oxidation facilities must have considerable operating flexibility. Because of the many factors involved, a thorough study of the operation should be made before a plant installation is undertaken.

—*R. L. Purvin.*

Olefin Production

Q I am very interested in olefinic production from lighter hydrocarbons, ethane through butane, and find very little material pertaining to this subject in trade journals or our state library. I would like to know of processes developed or under development, other than the normal resultant yield from cracking, and the methods and reactions, the time element, catalysts, yields, and some idea of costs (of production of various olefins). Help as well as reference (literature) on this subject will be appreciated gratefully.

—Benny Wilder.

A To answer fully this question would require volumes. No specific economic answers could be given without a detailed process engineering study. It is more practical to outline the main points in general terms and give a few literature references than to attempt to answer in detail.

The production of ethylene by the thermal cracking of hydrocarbon gases and distillates has been practiced in this country on a large scale for some years. Ethane and propane, or mixtures of the two, have been the basic feed stocks employed in many cases though the actual furnace charge frequently contains substantial concentrations of propylene recycle to the cracking operation. The great majority of the main product, ethylene, produced by cracking today is made in tube heaters with alloy steel tubes.

The ethylene rich effluent from the cracking furnace production is at 15 to 30 lb gauge and temperatures between 1350 and 1450 F. Alloy tubes are used because of less tendency to creep under stress at temperatures above 1200 F. Also with alloy steel there is markedly less catalytic dehydrogenation of the olefins formed. In order to minimize coking and to lower the partial pressure of the reacting gases, steam dilution is frequently employed but this increases fuel and water consumption.

In order to prevent undue loss of ethylene by dehydrogenation to acetylene and condensation products of the two, it is necessary that time in cracking zone approximate two seconds or less at about 1400 F. As the temperature increases, the permissible time of contact decreases though the conversion and yields increase under ideal conditions. In tube furnace cracking, conversion per pass is about 30 to 35 per cent and the weight yield of ethylene will be in the range of 30 to 35 per cent based on fresh feed. Cracking tube temperatures in ethylene production are limited by the materials of construction available and an economic balance on their use. Consideration has been given to the catalytic dehydrogenation of ethane which, with its potentially higher yields at lower cost than propane, has much to recommend it. To date, however, catalytic dehydrogenation of ethane apparently has not yet proven economic because of the much higher investment required for the ethylene conversion equipment and the consequent higher amortization charges with this process as compared with tube cracking. The Thermofor pyrolytic cracking process developed by Socony Vacuum obviates the necessity for tube cracking by circulation of a stream of heated refractory pebbles through the reaction zone where they give up a portion of their sensible heat to the hydrocarbon gases flowing across them. Hot pebbles continuously feed into the reaction zone and cool pebbles are continuously withdrawn to be reheated and returned mechanically to the reaction zone. This process shows promise of lowered costs. It is believed that as yet there are no commercial installations of this process.

Ethane cracking is essentially a thermal dehydrogenation and in the cracking of propane methane is split out leaving an ethylene residue. This statement is an over-simplification as it is believed that many of the hydrocarbon molecules are to a very large extent broken into free radical fragments that recombine to give many of the higher molecular weight hydrocarbons found in the cracker effluent.

The matter of costs of production of various olefins is a complex subject. An ethylene plant represents a large capital investment for a process that to date has been relatively low yield with consequent emphasis on the importance of feed stock costs. Any serious study of ethylene costs is a highly involved process engineering problem and cannot be answered briefly here. It is of the first importance that any ethylene unit have a high on-stream time efficiency in order to minimize the effect of capital charges on production costs. It is probable that some of the newer processes will give the lowest ethylene costs in new installations.

The matter of ethylene recovery and purification is almost equally complicated cost-wise and is determined by the mode of purification selected and the purity of ethylene required. Refrigerated oil absorption combined with fractionation is a commonly used method of recovery. A newer process called hypersorption uses the preferential adsorption characteristics of activated carbon to effect recovery from the hydrocarbon stream and purification.

The above remarks have been directed to ethylene, which is more widely sought after for chemical purposes than are propylene and butylene. Propylene can be recovered fairly readily by oil absorption from refinery gas or it may be bled off from an ethylene unit based on the cracking of light hydrocarbons. Butylenes may be recovered from refinery gas mixtures. Phillips Petroleum Company, in operations for Rubber Reserve, makes them on a large scale for ultimate conversion to butadiene by the catalytic dehydrogenation of normal butane.

A partial list of ethylene literature references is below:

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4. Kniel, L., and Slager, W. H., Chem. Engr. Prog., *43*, 335-42 (1947) Ethylene Purification by Absorption Process.
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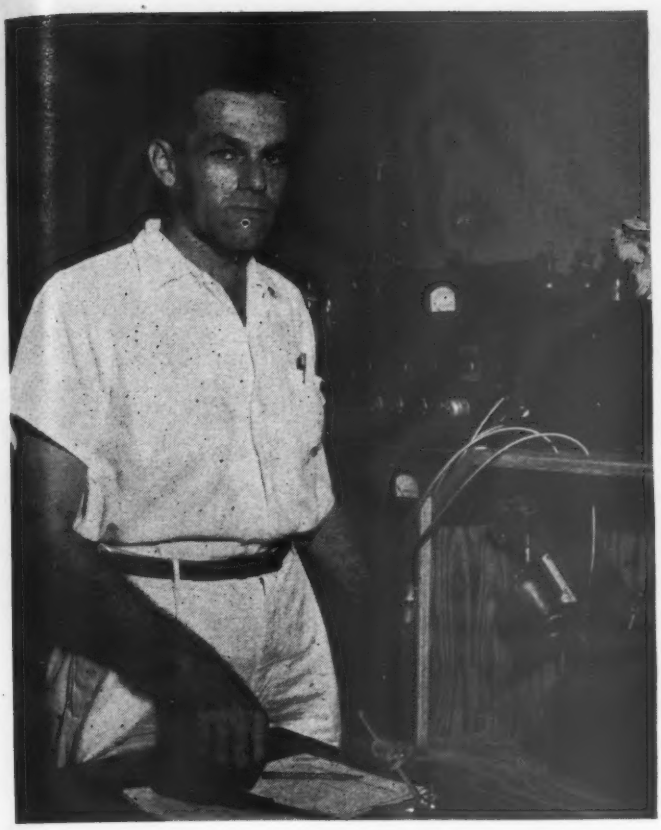
6. Pratt, A. W., and Foskett, N. L., Trans. Am. Inst. Chem. Engrs., *42*, 149-63 (1946). Low Temperature Processing of Light Hydrocarbons.
7. Schutt, H. C., Chem. Engr. Prog., *43*. 103-16 (1946). Production of Ethylene from Ethane, Propane.
8. Smoley, E. R., Torrey, R. M. and Kniel, L., World Petr., *18*. No. 12, 78-81 (1947) Chemicals from Petroleum.

—*Dr. J. H. Boyd.*

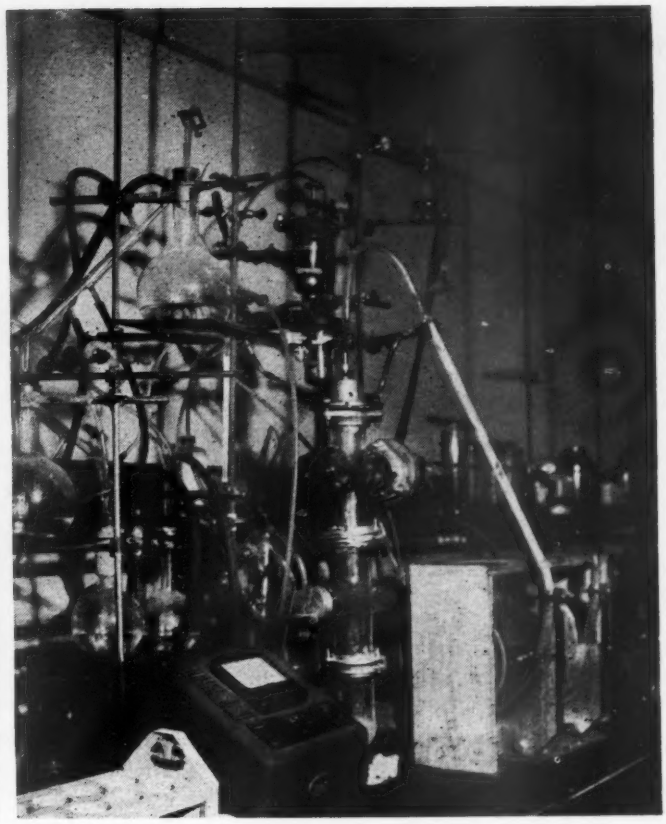
THIS IS FOR YOU

This Forum is a meeting place each month for engineers, technologists, students, operators, and all others interested, where each may profit not only by answers to his own knotty questions, but learn as well by reading the answers to the questions of others in the industry, answers submitted by the leading scientists and engineers in the world of oil and gas.

Address all questions to **Technical Forum Editor, Box 1589, Dallas 1, Texas.** Send them in right away while you think of it.



Dr. Norman Hackerman, director of the Corrosion Research Laboratory at The University of Texas.



This apparatus, designed and perfected in the Corrosion Research Laboratory, enables study of corrosion processes similar to those in gas condensate wells.

Radioisotopes Aid Corrosion Research

JACK M. SWARTOUT

EVER since radioisotopes have been made available in weighable quantities from the Clinton Laboratories at Oak Ridge, Tennessee, the radioactive tracer technique of research has been applied to investigations of many different phenomena. Radioisotopes have been particularly valuable in the study of involved biological reactions, but scientists at The University of Texas are finding them also useful in a study of corrosion.

Work of this nature is being done in the University's Corrosion Research Laboratory, which was set up five years ago under the sponsorship of the Natural Gasoline Association of America and the Office of Naval Research. Norman Hackerman, associate professor of chemistry, is the director.

The investigations being carried out at the Corrosion Research Laboratory are of a fundamental nature, the main inquiry being concerned with a study of minute differences on the surface of metals. Virtually every exposed metal, Hackerman explained, presents a highly diversified or non-homogeneous surface. He believes that it is these small differences that may influence the way in which corrosion occurs.

It is now well known that corrosion is often an electro-chemical phenomenon, quite similar to that which takes place in an ordinary primary battery. When the sal ammoniac solution of a dry cell reacts with the zinc canister, the zinc is decomposed. Likewise, when an electrolyte comes into contact with metal, galvanic cells are set up, with certain areas on the metal becoming anodes. And, just as the zinc anode of a battery is decomposed in the process of producing a current, so the anodic areas on the surface of the metal corrode. It is this feature of electrolytic corrosion that makes it possible for sacrificial anodes, made of zinc, magnesium, and other baser metals to be used to suffer the effe ts of corrosion rather than iron and steel.

As metals corrode in different ways at different areas, it follows that a thorough knowledge of the individual differences on the surface of metals will be of value in a study of corrosion. Hackerman believes that radioisotopes may enable him to locate

EXCLUSIVE

sensitive spots on metallic surfaces and to determine the effects of certain salts in decreasing the resistance to corrosion.

The technique involves exposing samples of metal to substances that contain a radioisotope. At the present time, stearic acid is being tagged with Carbon 14, the immensely useful radioisotope that has been used widely in tracer experiments. Prior to the war, it was produced mainly by cyclotron bombardment at a cost of $1,000,000 per millicurie, but now it is being distributed from the Clinton Laboratories at $50 for the same amount.*

After being tagged with Carbon 14, the stearic acid is applied directly to the metal. The disposition of the acid molecules on the metal surface can then be traced by means of the radiations emitted by the Carbon 14. A Geiger-Muller tube and scaler unit are the instruments used to detect the presence of the tagged molecules.

Besides Carbon 14, other radioisotopes have been used in these tests. The investigators have been using Chlorine 36 for about one year, and they have also experimented with radiosulfur. In the near future, they intend to conduct investigations with the radioisotope of chromium.

A number of other investigations are being conducted at the Corrosion Research Laboratory. One of these is a study of the process of corrosion in high-pressure condensate wells. Until recently, Hackerman and his assistants, one of whom is the holder of a fellowship in physical chemistry awarded by the Natural Gasoline Association of America, had to carry on experiments of this nature "on location" at gas fields. Now, however, having perfected a useful apparatus in the laboratory, they are able to carry on their investigations on the campus.

The apparatus is one in which steel coupons, enclosed in a glass, air-free system, are exposed to a spray emulsion of a solution containing water, gas, light petroleum fractions, fatty acids, and carbon dioxide. The steel coupons can be removed to determine their loss of weight due to the corrosive action of the fluids flowing over them, and to ascertain other chemical reactions that have taken place.

"Although this apparatus does not pretend to simulate actual conditions in gas condensate wells," Hackerman explained, "the principle is somewhat analogous, and the findings may have some direct applications."

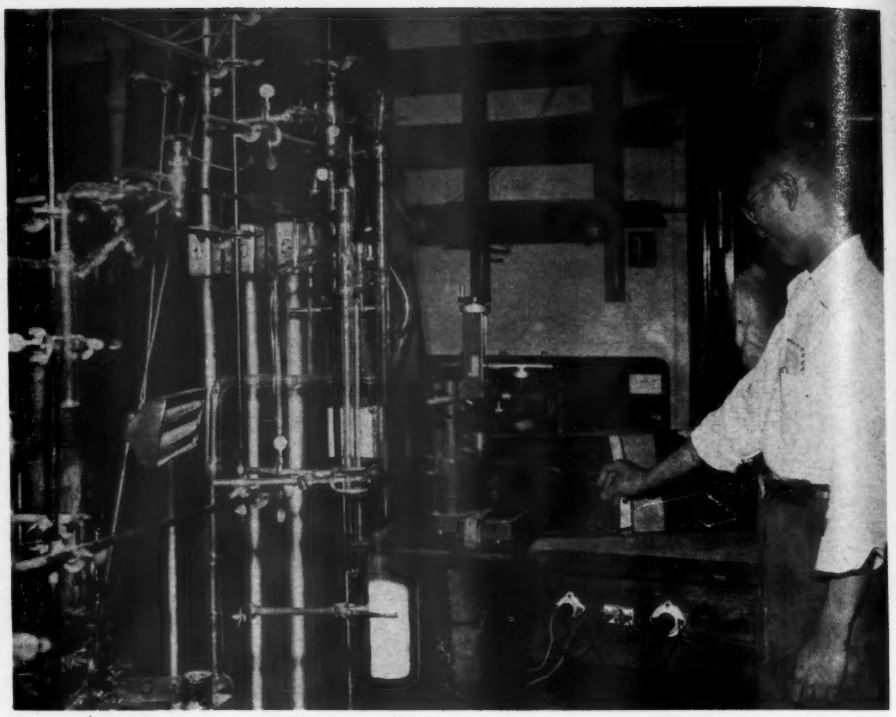
Another phase of the work being done at the Corrosion Research Laboratory is an investigation of the effects of the adsorption of certain gases at varying pressures on metal reactivity. An apparatus has been set up in which metal powders (six different metals are being studied) are subjected to gases at rather low pressures. Minute increases in the weight of the powder due to adsorption can then be determined with sensitive weighing devices. Experiments of this nature have recently been carried out with chlorine gas.

Another study is concerned with the effectiveness of different chemicals as corrosion inhibitors. Fifty different chemicals are being studied, in 115 different concentrations. In these experiments, steel powder (steel is the only metal being investigated) is exposed to the inhibitor solutions for four of five days, after which it is removed and weighed to determine the amount of adsorption that took place. Then, to ascertain the effectiveness of this acquired coating in preventing rust, the treated steel is subjected to acid solutions. The amount of corrosion resulting is then compared with that which takes place with ordinary untreated steel powder.

"Some favorable findings have been obtained in these tests," said Hackerman. "In some cases corrosion has been retarded as much as 90 per cent." So far, the best results have been obtained with the fatty acids, or amines.

"Of more importance, however," added Hackerman, "is the fact that a direct relationship probably exists between the non-uniformity of metals and the ability of those metals to adsorb different inhibitor chemicals firmly at different sites. Therefore, once a thorough knowledge of the surface differences of metals has been obtained through the help of radioactive tracers, it may be possible to perfect a mixture that will function more effectively as an inhibitor than one chemical alone."

Although the final experiments with radioisotopes will not be ready for publication for some time to come, Hackerman believes that the ultimate finding may prove of great value to corrosion engineers. * * *



A technician at the Corrosion Research Laboratory controls an apparatus in which metal powders are subjected to gases to determine the effects of adsorption on metal reactivity.

*"Year of Isotopes," *Time*, L (August 11, 1947), p. 72.

Oil Wells Produce Iodine

The petroleum industry is now supplying nearly half of the 1,500,000 pounds of iodine used annually in the United States. The iodine, used chiefly as an antiseptic, is obtained from the brine that comes up with oil from producing wells in some areas. This product was first recovered from Louisiana wells in 1926, but recently West Coast oil wells have been supplying iodine in such large amounts that imports—and dependency upon foreign production—have been decreased greatly.

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NEWS

Tennessee Gas Plans Two Kentucky Plants

Tennessee Gas Transmission Company is considering plans for building two gas plants in or near Meade and Greene Counties, Kentucky. Should the plan go through, the company proposes to build a plant at or near Greensburg to process natural gas brought there through pipe lines. The other plant, near Brandenburg, would process or treat the products removed from the natural gas in the first plant.

Japan Resumes Oil Refining

Japan has begun refining oil products for its own use from imported crude oil for the first time since World War II, it was announced by Standard-Vacuum Oil Company. Standard-Vacuum is jointly owned by Standard Oil Company (New Jersey) and Socony-Vacuum Oil Company, Inc.

Toa Nenroy's Shimizu refinery, in which Stanvac bought an interest recently, has begun operations and will soon be going at the rate of 4000 bbl a day. Toa Nenryo also owns the Wakayama refinery, which is still being reconstructed, and which is due to begin producing at about 6000 bbl a day early this month.

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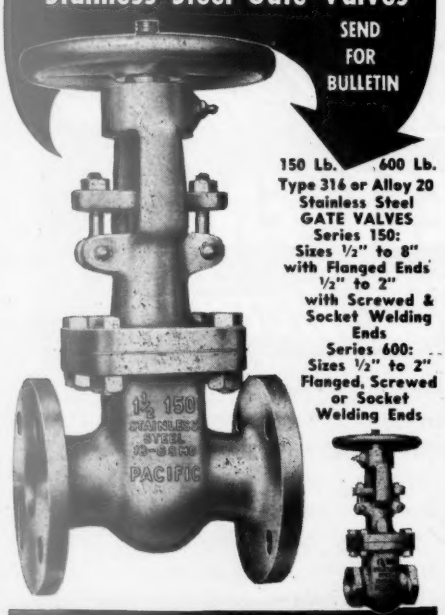

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British American Announces Canadian Refinery Projects

British American Oil Company, Ltd., has awarded an engineering and construction contract to Canadian Kellogg Company, Ltd., for all processing equipment at a proposed plant in Edmonton, Alberta. The other scheduled major job in this growing refining area is for Imperial Oil, Ltd., at Winnipeg, Manitoba.

The new refinery will have an annual capacity of 2,000,000 bbl and will include the following equipment: A combination crude oil distillation and thermal cracking unit, a coking unit, a fluid catalytic cracking unit, and a complete chemical treating plant.

The new refinery will process crude from Redwater, which is to be brought to the refinery by pipe line. With the completion of this new refinery, British American will have three western refineries with a total capacity of 6,500,000 bbl per year operating on western Canadian crude.

Pilot Plants Set up by Shell

A research program to lower the distribution costs of petroleum products has been inaugurated by Shell Oil Company in 15 specially designated "pilot plant depots." Progress of studies now underway in the distribution centers is being reviewed by Stokes Tomlin, distribution engineer for Shell and chairman of the distribution committee of the American Society of Mechanical Engineers.

Rather than build new units for the studies, Shell chose existing plants in order to keep the test facilities as similar as possible to those in the remaining installations. The test units are actually distribution laboratories in which the microscope is being put on costs of operations involved in moving gasoline, fuel oil, and other products from the plant to the ultimate consumer. Key subjects for investigation are clerical procedures, warehousing, routing and dispatching of trucks, safety, and the physical appearance of plant facilities.

Refinery Begins 2nd Year Of Continuous Operation

The second year of continuous operation without shutdown began at Sunray Oil Corporation's catalytic cracking refinery, south of Duncan, Oklahoma, last month. The big cat-cracker put the 3.6 millionth barrel of gas oil through, completing 365 days of running since going on stream March 7, 1949, after a turnaround operation. The cat-cracking unit was operated at 99 93/100 per cent efficiency.

Standard to Reduce Heavy Fuel Oil Production

A multimillion-dollar program designed to relieve a growing over-production of heavy fuel oil in California was announced by T. S. Petersen, president of Standard Oil Company of California. The new program involves:

1. Conversion of Standard's giant TCC (Thermofor Catalytic Cracking) unit at Richmond to a new refining process,

2. Construction at Richmond of a new vacuum tower capable of handling 50,000 bbl of oil daily,

3. Integration of many existing plants into the new processing program.

Two favorable results are expected from the program. A marked refinery wide reduction in the amount of heavy fuel oil produced and a substantial increase in the manufacture of gasoline.

Conversion of the TCC plant involves a change to the new houdriflow process. This will increase the unit's coke burning capacity 60 per cent by enabling it to handle 500 tons of catalyst an hour. The new vacuum flasher will have a diameter of 26 ft. The vacuum unit will process heavy oil residue of other refining processes in the Richmond plant.

Three Chemical Meetings Set for September, 1951

Three chemical organizations of international importance will meet in New York City in September, 1951. The 75th anniversary meeting of the ACS is scheduled for the week beginning September 2; the following week the meetings of the International Union of Pure and Applied Chemistry, and the Twelfth International Congress of Pure and Applied Chemistry will convene in the same city.

The International Union meets every two years to set uniform chemical standards for scientists and engineers, and will render decisions on questions of atomic weights, nomenclature of chemical matters. President of this union is Hugo R. Kruyt of The Hague, Netherlands. Both international meetings are sponsored by the division of chemistry and chemical technology of the National Research Council and plans are being directed by Harry L. Fisher, retired research director for U. S. Industrial Chemicals, Inc. A drive for $250,000 in funds to finance the meeting is being undertaken under the direction of E. R. Weidlein, director of Mellon Institute of Industrial Research.

Burning table and remote controlled extinguisher set up in the frigid chamber at the Engineer Research and Development Laboratories for low-temperature tests of new bromofluorocarbon agents. These experiments were conducted at temperatures down to minus 65 F.

Research on Fire Extinguisher Compounds

Members of the bromofluorocarbon group of compounds have shown extraordinary efficiency in extinguishing fires that were not affected satisfactorily by the application of carbon tetrachloride or carbon dioxide, the Ordnance Department of the Army has announced. The experimental work is being carried on at the Engineer Research and Development Laboratories at Fort Belvoir, Virginia.

The original research on this problem was carried out at Purdue University, followed by Class B and Class C fire tests at the ER&D laboratories at Fort Belvoir. A large number of extinguishing agents were tested under Standard Underwriters Laboratory procedures, at various temperatures down to minus 65 F. This process screened out the least attractive compounds. As the new agent to be adopted will be used to fight fires in vehicles, shelters, and other enclosed locations, the toxicity of the agent is of importance. Preliminary tests indicate several of this group of compounds are non-toxic, but adoption of the compound will be deferred until the results of toxicity tests being carried on at the Army Chemical Center become known, and will be based also on commercial availability of the product otherwise found most satisfactory.

Natural Gasoline Output Up 10 Per Cent for 1949

Texas produced three and one-half trillion cubic feet of natural gas in 1949, the Railroad Commission reported, a 10 per cent increase for the year, and about 30 per cent over 1945. More than one-half trillion cubic feet of gas went back into the ground after cycling plants had removed liquid fuels. Carbon black took one-third trillion feet of gas, and pressure maintenance projects for oil fields another one-fourth trillion feet.

From gas wells, liquid hydrocarbons totaled 94,277,712 bbl last year. Fifty-three million barrels gasoline and 24,000,000 bbl of butane and propane were included. Gasoline plants produced 62,000,000 bbl from casinghead gas, including 41,000,000 of natural gasoline and 17,000,000 bbl of butane and propane.

Ion Exchanger Signals Exhaustion Point

Use of a special dyed mixture of Amberlite resins that change color as the bed becomes exhausted has been developed by the Resinous products division of Rohm and Haas Company. The Monobed technique itself delivers water extremely free of ionic impurities by a single passage through the bed of exchangers. The Monobed provides complete deionization, yielding a product with a mineral content of less than one part per million from ordinary faucet water. The new feature checks the exhaustion point of the bed.

Dyed a dark blue in its regenerated state, the Monobed becomes a yellowish brown when exhausted. The user, operating such a bed in a transparent tube or vessel, can watch visually the latter color travel slowly down the bed as exhaustion advances.

Polytechnic Gets Research Grant

The Research Corporation of New York has made a grant of $5500 to Polytechnic Institute of Brooklyn in support of a $6800 research project (1950-51). The project will be the study of plate efficiency in distilling columns under the direction of Ju Chin Chu, associate professor of chemical engineering.

Two predoctoral fellowships for the project are now available at the annual stipend of $2000.

Co-op to Expand Refinery

The National Co-operative Refinery Association has announced a $2,000,000 expansion program for its refinery in McPherson, Kansas. Capacity of the plant is to be increased from 18,000 bbl of crude oil daily to more than 22,000 bbl daily by addition of a new catalytic cracking unit, a polymerization unit, and other modernizing changes. Contract for construction has been let to the Refinery Engineering Company, Tulsa, Oklahoma.

The company also announced it would expand its tank farm in McPherson from 1,500,000 bbl storage capacity to 1,700,000 bbl.

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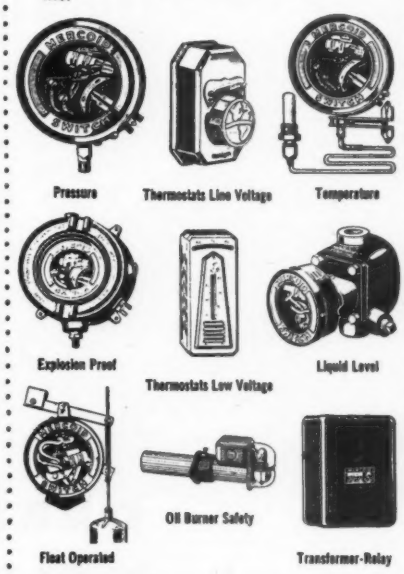

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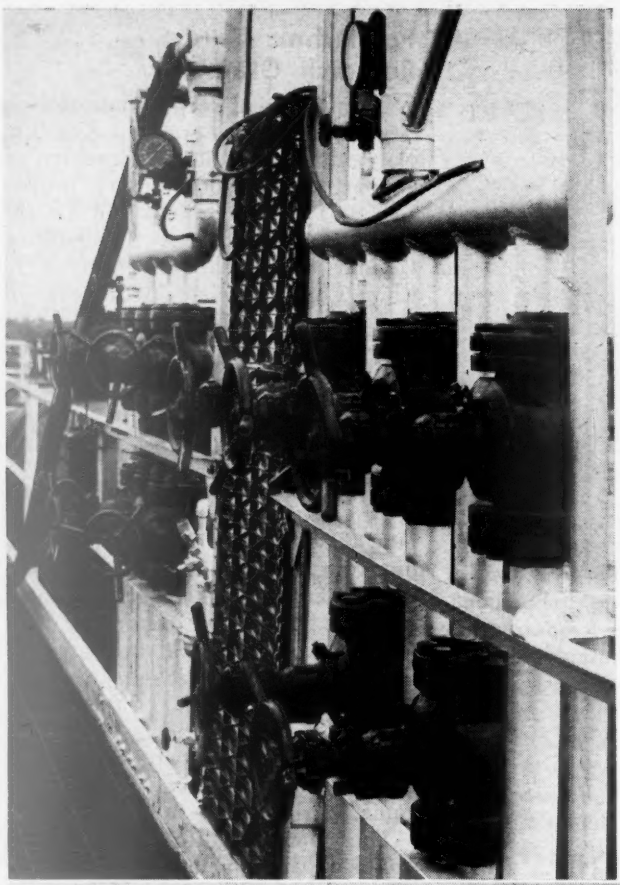
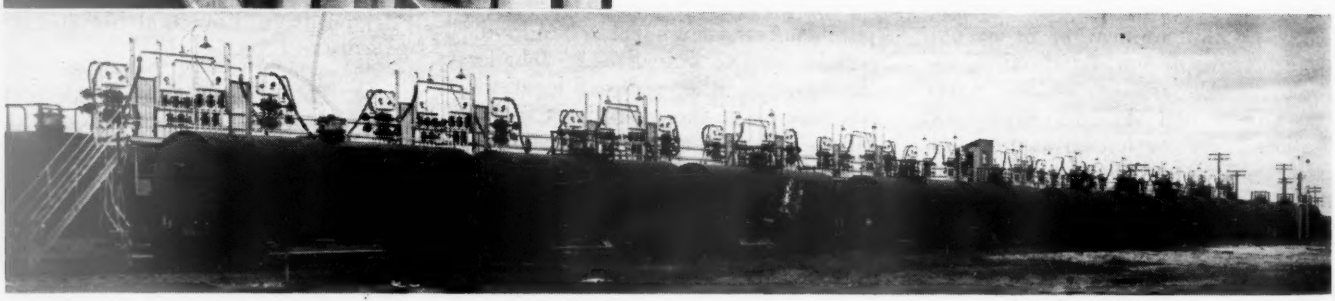


ORBIT VALVES

285 ORBIT FORGED STEEL FLOWLINE VALVES went into this huge Carloading Rack at the new Seeligson Plant, Jim Wells County, Texas near Premont, jointly owned by a group of Seeligson Field Operators, Magnolia Petroleum Company being the Plant Operator.

ORBIT VALVES at this installation are handling Propane, Butane and Isobutane.



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The ORBIT FORGED STEEL FLOWLINE VALVE is a progressive approach to the solution of Valve problems of Plant men everywhere. ORBIT VALVES are giving outstanding service in Gasoline Plants over the country and will reduce maintenance costs that are being daily multiplied because of leaky valves and expensive lubricants.

ORBIT'S Friction Free seating principle gives a positive shutoff. The Stem is Plastic Packed which is permanent and effective.

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ORBIT FORGED STEEL FLOWLINE VALVES can be furnished with Carbon Steel Trim (Oil Country Rated) with a maximum working temperature of 250° Fahr. or with Stainless Steel Trim for corrosive services and intermediate temperatures up to a maximum of 375° Fahr. Flanged End or Screw End. Sizes 1", 2", 2½", 3" and 4".

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Wood River Unit Put on Stream

The fluid catalytic cracking unit recently completed at Wood River Oil and Refining Company, Hartford, Illinois, has completed test runs and is now on stream. Design capacity of the fluid unit is 7500 bbl a day of gas-oil charging stock. Addition of the catalytic cracking equipment raises the daily capacity of the Wood River refinery to 35,000 bbl as compared to 10,000 bbl before the war.

Operations of the catalytic cracker will materially improve the octane of Wood River housebrand and premium gasolines as well as increasing gasoline yields. Yields of domestic burning oils will also be larger, Fred C. Koch, Wood River president stated.

Shell Opens Gas Plant In Provident City Field

Shell Oil Company's new South Texas gas plant, situated in the Provident City field, went into operation the first of this month. About 50,000,000 cu ft of residue gas will be dehydrated and sold to the Texas Eastern Transmission Corporation, which recently obtained permission from Colorado County to lay a 16-in. pipe line across the southern part of the county.

General contractor of the new plant is the Flour Corporation, with C. H. Followell as superintendent. George Bertram, district gas plant superintendent at Sheridan will also supervise the Provident gas plant operations, Shell officials stated.

Sinclair Develops New Litholine Greases

A new multipurpose grease to be known as Litholine, is being placed on the market by Sinclair Refining Company. This grease is made up of lithium soaps and refined mineral oils and will replace the many types of greases supplied formerly. The product has been tested in the laboratory and on the road for more than a year before being offered to the public.

Consulting Chemists to Meet

Association of Consulting Chemists and Chemical Engineers, Inc., will hold a dinner meeting on April 25, at 5:00 p.m., at the Shelburne Hotel, 37th Street and Lexington Avenue, New York City, Skyline Room.

Gasoline Plant to Be Built For Shell in Elk City Field

Plans for construction of a large-scale gasoline extraction plant in the Elk City field, Beckham and Washita Counties, Oklahoma, have been announced. This plant will be constructed by the Refinery Maintenance Company, Houston, Texas, and construction will begin immediately. When completed, the plant will be capable of handling approximately 100,000,000 cu ft of gas daily, and is designed to permit the adoption of facilities to provide cycling, repressuring, and crude stabilization.

The total investment of Shell and other companies in the field is expected to exceed $32,000,000 by the end of 1950. By conservative estimate, drilling alone now represents a direct investment of about $8,000,000. Shell Oil, operating 17 rigs in the field, anticipates drilling approximately 50 more wells during 1950 at a cost of about $10,000,000.

New Spectroscopy Course Will Be Taught at MIT

A new, intensive course in infrared spectroscopy as a research tool will be offered by the department of chemistry of Massachusetts Institute of Technology during the 1950 summer session, Walter H. Dale, in charge of the summer school, has announced. Two one-week classes, accommodating 25 sudents each, will be conducted by R. C. Lord and F. A. Miller. The two courses begin on July 24 and July 31, respectively. Tuition for the week is $90; for lectures only, $50.

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Plans Made for Oil Refinery in England

Proposed construction of a complete oil refinery, specializing in high grade lubricating oils, at Coryton, England, was announced recently in London by the Vacuum Oil Company, Ltd., a subsidiary of Socony-Vacuum Oil Company, Inc. The refinery will have a capacity of approximately 20,000 bbl a day and will cost about $30,000,000.

It was also announced that the refinery operations, as well as Vacuum's present marketing facilities in the United Kingdom, will be merged with the oil storage, blending, and packing business conducted at Coryton by Cory Brothers and Company, Ltd., wholly owned subsidiary of Powell Duffryn, Ltd.

The new refinery, plans for which have been under discussion for several months, will treat Middle East crude oil primarily, and the resulting products will replace those at present imported from dollar sources. The refinery is expected to go on stream in about 30 months.

Rincon Gasoline Plant Enlarged

Enlargement of the Continental Oil Company-operated Rincon natural gasoline plant near McAllen, Texas, has been completed at an expenditure of $1,300,000. Daily capacity of the plant has been increased from 13,000,000 to 20,000,000 cu ft of gas.

The expanded plant, 45 miles northwest of McAllen and 20 miles northeast of Rio Grande City, will have a daily production capacity of approximately 16,000 gal of liquid petroleum gas, and approximately 25,000 gal of gasoline. The plant will return about 8,500,000 cu ft of gas to the five main reservoirs daily.

Originally a gas compressor unit, the installation was developed into a natural gasoline plant in 1945. The plant now serves the Rincon field, which includes more than 150 oil wells.

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No other pipe, at reasonable first cost, offers comparable resistance to both interior and exterior corrosion. No other pipe, in its price range, is as economical in the end. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

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—PERSONALS—

L. O. Crockett

L. O. Crockett, formerly assistant general superintendent of the Gulf Oil Corporation's refineries in Port Arthur, Sweetwater, and Fort Worth, Texas, has been transferred to the company's general offices at Pittsburgh, Pennsylvania, and appointed manager, technical division, of the manufacturing department. In his new position, Crockett will supervise direction of the company's several refinery laboratories and the refinery technology division at Philadelphia. He also will serve as liaison of the manufacturing department in dealings with the Gulf Research and Development Company and with the domestic and foreign marketing departments on questions relating to product quality.

A graduate of the University of Texas where he continued as an instructor for several years following his graduation, Crockett joined the Gulf Companies in 1922, when he was employed as assistant chemist in the experimental laboratory at Port Arthur. Six years later he was promoted to foreman of the plant used in the manufacture of Alchlor Processed oils. In 1934 he was appointed chief chemist for the three Gulf refineries in Texas. In 1945 he was made assistant general superintendent in charge of refinery laboratories and technology.

R. G. Bandy, Tulsa, Oklahoma, was recently named manager of the Midland Cooperative Wholesale Refinery at Cushing, Oklahoma. He succeeds **Rex W. Winget,** who retired on April 1.

William Storck, Roselle Park, New Jersey has been appointed foreman at Tide Water Associated Oil Company's Bayonne, New Jersey, refinery. He was formerly shift engineer in the Bayonne refinery.

Harry A. Jarvis, who has been manager of the refinery department of Creole Petroleum Corporation since 1949, has been named a member of the management committee of the company. He joined Creole in Venezuela in January, 1947, when he was named assistant manager of the refinery department. In 1948, he was manager of the Creole refinery project at Amuay Bay on Paraguana Peninsula in northwestern Venezuela.

Jarvis is a graduate of the University of Maryland, after which he joined Standard Oil Company (New Jersey) at its Bayway, New Jersey, refinery. In 1931 he went to Argentina as a junior engineer at the Campana refinery of Cia. Nativa de Petroleo, a Jersey Standard affiliate.

Joseph H. Salmon, widely known in management circles of the oil and gas industries, has set up offices as management consultant, at 201 East 57th Street, New York City. He will specialize in oil, gas, chemical, and allied industries. Salmon served 27 years with Shell Oil Company in responsible positions such as assistant to the chief engineer, manufacturing vice president, and also the president; as chairman of the economics committee and the long range planning committee of that company.

He is a graduate of Pennsylvania State College and the St. Louis University Law School.

Ralph E. Deeds, technical assistant in the refining and oil-movement department, Esso Standard Oil Company refinery, Baton Rouge, Louisiana, has been promoted to assistant general foreman, refining division.

Mario Mura, petroleum engineer with Raffinerie Siciliane Oli Minerali, RASIOM, with refineries at Milano and Augusta, Italy, is making a tour of the American refining industry in the interest of his company, studying refining methods and investigating possibilities for Italian operations. The RASIOM organization purchased the Danciger refinery at Longview, Texas, and is transferring it to Sicily where it will be set up as a topping refinery, to operate on Middle East crudes. The company plans to add a catalytic cracking unit and other facilities, including a complete lubricating oil refinery to round out the list of products made, destined for European and Eastern Hemisphere distribution.

Fred C. Koch, president of Wood River Oil and Refining Company, Wichita, Kansas, was appointed chairman of the Petroleum Tax Committee, by the Board of Directors of the Independent Refiners Association of America.

D. W. Hovey, president of Danaho Refining Company, Houston, Texas, will head the Petroleum Economics Committee. This committee will make a study of all phases of economics affecting the independent refiner. Included in this study will be an analysis of the impact of recycling operations as affecting the independent refiner and the industry as a whole. This committee will study taxes at all levels.

J. Bennett Hill, director of the chemical and engineering division of Sun Oil Company's research and development department, recently was appointed chairman of the Subcommittee on Aircraft Fuels of National Advisory Committee for Aeronautics.

Edward C. Dobbertin was recently presented a gold watch by the board of directors at the general office of the company in Chicago in recognition of 50 years of service with Standard Oil Company (Indiana). **M. G. Paulus,** vice president in charge of manufacturing, made the presentation. Dobbertin, a water drawer and loader in the filtering oils department at the Whiting refinery, retired on company annuity March 4.

In 1900 he was employed in the grease works at Whiting. After working in the barrel house from 1910 to 1916, he returned to the grease works and remained there until 1942 when he was transferred to the filtering oils department.

H. P. Hargis has been appointed president of Premier Oil Refining Company, of Texas, and general manager of Premier Petroleum Company. He is succeeding **Sylvester Dayson,** who resigned.

James H. Heslar, a Pure Oil Company employee since 1917, has been named superintendent of construction and maintenance at Smiths Bluff refinery, Nederland, Texas. **Joseph B. Price** has been appointed superintendent of the lube and grease division at the refinery. He has been with Pure Oil for 26 years.

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"Karbate" Impervious Graphite tube-bundle heat exchanger, floating-end diaphragm construction, used for partial concentration of H_2SO_4 contaminated with volatile organics. Contains 233 tubes, ⅞ in. dia. by 9 feet long. Tube sheets are 28¾ in. dia. by 6¼ in. thick.

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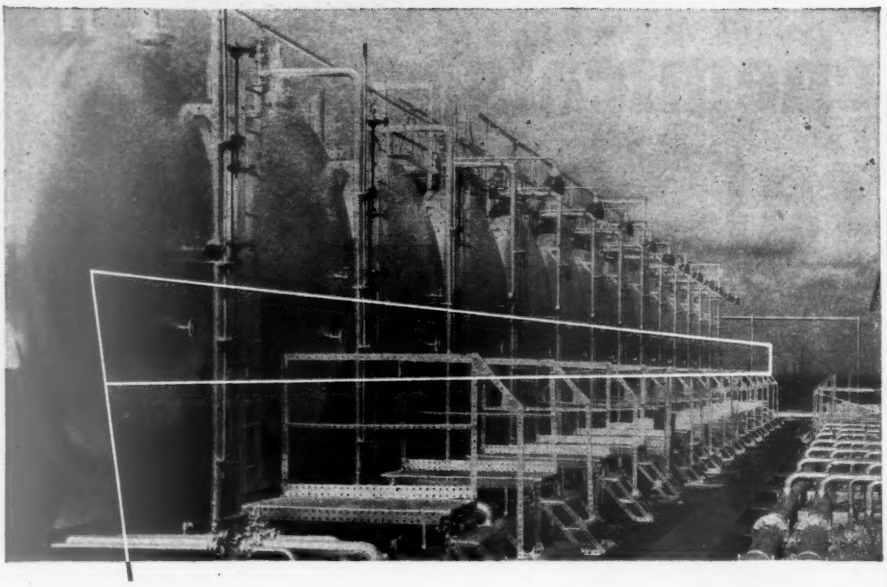

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WESTON *Instruments*

Chemical Engineers Discuss Problems at Houston

A large number of papers discussing various phases of distillation, absorption, and phase equilibria were presented before the regional meeting of the American Institute of Chemical Engineers at Houston, Texas, February 26-March 1, papers which are of primary interest to petroleum refining research and supervisory personnel. Symposia on phase equilibria were held under the direction of Wayne C. Edmister, Carnegie Tech, and W. L. Nelson, Tulsa University. Other general sessions presented numerous subjects of interest to the petroleum and chemical industries, which are represented widely on the Gulf Coast.

A new refrigerant mixture, called Carrene 7, was announced by W. A. Pennington of Carrier Corporation and W. H. Reed of Syracuse University. It is an azeotrope of Freon 12, already well distributed as a refrigerant, and Genetron 100, or 1,1-dichlorethylene, which is referred to also as a "refrigaloy." This product has been developed largely to provide a refrigerant that will show the same capacity when used with 50-cycle electric current motors as does our present refrigerants with 60-cycle current operated compressor motors. Additional subjects discussed include thermodynamic analyses of vapor-liquid systems, extractive distillation for separation of hydrocarbons of narrow boiling point differences; and methods for calculations of equilibria for petroleum fractions by a new integral method, a subject presented by W. C. Edmister and J. R. Bowman of Mellon Institute. More than 500 attended the meetings of the Institute.

British Develop New Type Gas-Turbo Automobile Engine

A radical departure from conventional automotive engine principles is made in the experimental unit being designed by Cowal Engineering Company of England. This unit is described as a "gas-turbo engined unit" (automotive) designed by John Rhodes of Edinburgh. Its 33 hp (English rating) engine is said to include basically a pump, driven by a gas turbine, which drives oil through flexible hoses to a hydraulic driving unit connected with the wheels. It has no gears, clutch, or differential, and its performance is credited to be 45-50 mph with kerosine fuel. Engine air intake and lubrication are automatic, Petroleum Times reports. It is air-cooled, can be built for one-fourth the cost of a conventional piston engine, and weighs less than half that of a piston engine of the same power.

Western "Super-Inch" Gas Line Off to Good Start*

World's largest diameter pipe is being constructed from California to Arizona

Small bulldozer with 44-in. blade prepares to enter trench for final leveling.

THE world's largest diameter high-pressure natural gas transmission line is well under way. The first leg, an 80-mile section from Llanada, south of Hollister, California, to the San Francisco Bay area distribution station at Milpitas, is completed.

The "Super Inch" is so called because of its 34-in. diam. and its operating pressure maximum of slightly more than 800 psi. It will be 506 miles in length from Milpitas to Topock, Arizona, where it will connect with a double main of the El Paso Natural Gas Company from Texas and New Mexico gas fields.

Pacific Gas and Electric Company, supplying natural gas to northern and central California, is the builder. Construction is under contract to Bechtel-Price-Conyes as a joint venture sponsored by Bechtel Corporation.

Initial gas delivery will be 150,000,000 cu ft per day, with a contemplated ultimate daily supply of more than 400,000,000 cu ft.

Cost of construction has been estimated at about $63,000,000 for the California section. Nearly 200,000 tons of steel will be required.

There was a two-fold reason for laying first the western end from below Hollister to Milpitas. Peak loads in the San Francisco Bay region were overtaxing existing lines. With 80 miles of 34-in. pipe line completed, the section can be used as a loop main of the P. G. and E.'s Bay line between Kettleman and Milpitas to route increased deliveries of San Joaquin Valley gas to the San Francisco Bay area. To expedite early completion of the line, it was desirable also to build the coastal section first, thus taking advantage of the dry summer season of that area. Then, by completing the northern end in November operations, it was possible to transfer construction to Topock so that the crossing of the California desert is being made in the cooler months.

Work on the line is speeded up by the ingenious "double ending" of pipe before it is delivered to the right-of-way. As it comes from the fabricator, Consolidated Western Steel Corporation of South San Francisco, the pipe is delivered to a railhead plant where the 30-ft lengths are joined into 60-ft or 90-ft. lengths by a combination of machine and hand welding. For the first 80 miles of line the plant was situated at the outskirts of Santa Clara. There, only 60-ft lengths were possible, because delivery to the job-site necessitated routing over congested highways. Now the "double ending" plant is in the vicinity of Barstow and 90-ft lengths are being

Terrain between Hollister and Milpitas included but few difficult rock formations. The major rock encountered was soft sandstone. Roads were left open and a large pipe section pushed through to encase the 34-in. line.

*Prepared by staff members of Pacific Gas and Electric Company and Bechtel-Price-Conyes.

Self-propelled cleaning and priming machine travels on pipe raised clear of skids by caterpillar tractor with traveling sling.

The 32½-ton wheel type trencher, largest of its type in the world, excavates the trench for the pipe line.

produced. The final move of the plant, to take care of the last connecting section, will place it in the San Joaquin Valley at a point not yet determined.

The process of "double ending" includes receipt of the pipe by rail or truck. Unloading, loading, and handling of the pipe within the yard has been facilitated by a new adaptation of lift trucks. Nine-ton lift trucks with fork lift and special hauling devices handle with ease pipe units weighing as high as 7½ tons.

Pipe is unloaded from the railroad cars and set on roll-down rails, which convey it to the first operation, alignment of the 30-degree factory beveled ends of the adjacent lengths of pipe. A self-propelled internal lineup clamp travels down the length of pipe to the joining point where it expands to make spacing and alignment. A stringer weld is made by hand, the jig removed, and the pipe continues on roll-down rails to the next operation, another hand weld.

These hand welds account for but a small percentage of the total weld, the remainder being made by an electrically-driven machine welder. This machine, with automatic feed of both flux and welding rod, lays a finished bead that has a greater strength at cross section than the pipe itself. The entire process results in a great reduction in overall welding time. It also reduces handling time at the jobsite.

On the Line

The right-of-way is a strip 50 to 75 ft wide. The width is dictated by the fact that the heavy equipment to dig the ditch and handle the pipe must be allowed sufficient room for travel and maneuver. Benches are cut in the hillsides and to minimize grades it is sometimes necessary to make extensive cuts and fills. Where rocky soil is encountered, blasting becomes necessary. The numerous canyons, dry washes, and creeks require especially designed spans. The crossing of the Colorado River will be made with an overhead span but submerged crossings of dual 26-in. pipe will be laid at the Kern and Mojave Rivers.

Short-wave radio is employed to give the supervisors constant contact between themselves and the temporary field office. At the field office, a mobile trailer camp made up of three trailers, named "Trailer City" by the pipeliners, there is a 50-watt station. Jeeps and pick-up trucks in the field have mobile transceivers.

Most of the right-of-way is cleared of brush and trees with bulldozers. Sandstone is broken and removed with trench hoes. If hard rock is encountered and blasted, the debris is removed by this same equipment.

Operations

As soon as the right-of-way is cleared the big delivery trucks lay the pipe along the right-of-way as received from the "double ending" plants. Then the trench is excavated by the world's largest wheel-type digger, which opens a ditch 5½ to 8 ft deep and 48 in. wide in one operation. This machine weighs 32½ tons, is 50 ft long, and 10½ ft wide, one of the reasons for the necessity of a well prepared right-of-way. Where slopes are such that they preclude the use of the trencher several backhoes are used in conjunction with hand labor. A miniature bulldozer with a blade about 44 in. wide smooths the bottom of the trench to the proper specifications.

Surveyors then follow the line and mark each section of pipe to indicate bends made necessary by the curvature of the terrain. Practically all the bends are possible to accomplish by the use of a cold bending machine, as acute angles are held to a minimum. Where greater angles are necessary they are accomplished by the use of

factory bent sections welded into the line.

The machine for cold bending the pipe holds a length in a vise-like set of jaws and force is applied by means of a set of pulleys, to produce a "wrinkle" in the cold pipe. The cold bending limitations permit a maximum angular deflection per wrinkle of 1½ deg and a wrinkle must not be made closer than 5 ft from the end of a 60 ft pipe section and no wrinkle closer to another than one pipe diameter.

The bends made, larger sections, some as long as 4500 ft, are made up from the 90-ft lengths of pipe. Each 90-ft length is progressively welded to the section; an internal clamp similar to that used in the "double ending" plant being employed. Caterpillars with sideboom slings lift and hold sections in position while the alignment is made and the welders make the first stringer weld. As they proceed to the next section other welders finish the welded joint. Engineers of Pacific Gas and Electric Company inspect all operations.

These long sections are then cleaned and given a cold asphalt priming coat by a self-propelled pipe cleaning machine. The machine contains a series of revolving wheels. The first set holds metal star wheels to loosen the scale, the second set brushes to remove the scale and a compressed air jet that blows the dirt away. The same machine applies a coat of thin asphalt primer and wipes it to a smooth glossy finish, making the pipe ready for the next operation, wrapping. Sideboom tractors with rubber roller cradles hold the pipe clear from skids on the ground as both the cleaning and the wrapping operations are performed. The design of these tractors is a Bechtel development. To increase the lifting capacity by 30 per cent, the center of gravity of the tractor has been changed by a 22-in. extension of the axles near the sideboom attachment.

The major portion of the pipe is coated with enamel and wrapped with felt and kraft paper. The thickness of the coating exceeds ¼-in. A self-propelled machine does this in one operation. Certain sections will be wrapped with special glass fiber insulation.

After the coating and pipe have cooled to the proper temperature, the long section is lowered into the ditch and joined to the previous section. Backfilling of the ditch and clean-up operations follow the lowering. It may be of interest to note that because of the stiffness and weight of 34-in. pipe, lowering into the ditch becomes one of the major operations of the pipe line work. Depending on the terrain from 5 to 8 large and widened sideboom tractors are required to lower the pipe without damage to the coating or pipe. The line is handled during the operation with 30-in. wide rubber belt slings.

Design

At the time the "Super Inch" line was planned, the pipe manufacturer had developed machines and processes for making available, in quantity, 34-in. and 36-in. pipe. Engineers thus could choose between 30-in., 34-in., and a 36-in. diam pipe.

Factors affecting the choice of 34-

Wrapping the line over a coat of enamel. Sideboom tractors hold pipe suspended to permit travel of self-propelled machine.

Machine welding operation at "double ending" plant shown. Pipe is automatically rotated. Welding rod and flux are fed at optimum rates for the prescribed amperage.

in. instead of 30-in. included the following:

1. The 34-in. pipe would make equal volume deliveries at less horsepower. The savings amounted to approximately 10,000 hp., which when computed at $200 per installed horsepower gave a reduced capital outlay of nearly $2,000,000.

2. Using the 34-in. pipe, one less compressor station would be needed, resulting in a personnel and maintenance saving in annual costs.

3. Use of the 34-in. size would provide sufficient volume easily to equate the line; that is, the intake of the line could be held to a constant while the output might be varied as necessary to meet consumer demands without the necessity of floating gasholders.

4. The actual cost of pipe, by using a tapered line, would be equal to or less than that of 30-in. pipe.

5. Advantages of 36-in. pipe were practically the same as for the 34-in. pipe. Only small additional advantages would be gained in transmission but considerable higher costs would be involved in construction and construction equipment.

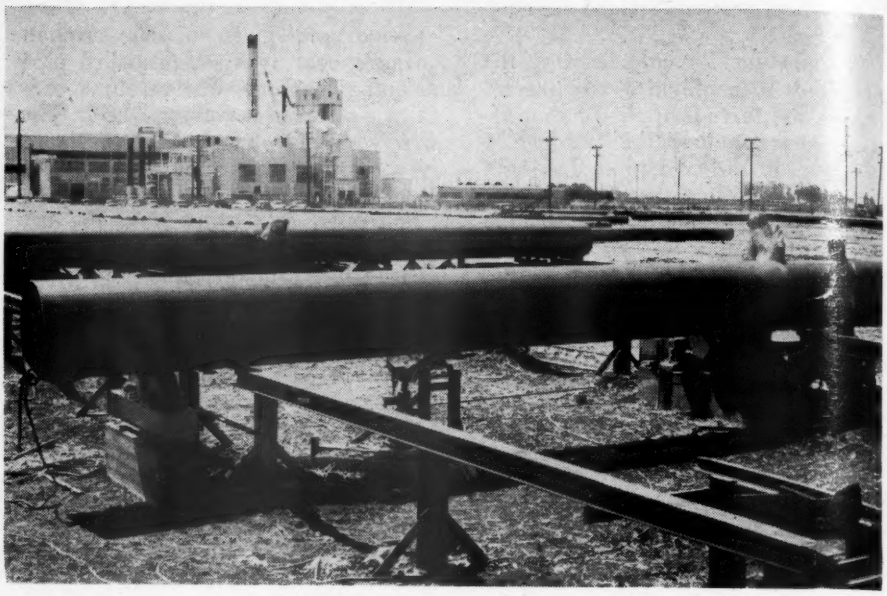
After deciding upon 34-in. pipe, wall thickness was determined. The guaranteed transverse yield strengths are:

52,000 psi for wall thicknesses of up to and including 3/8-in.

48,000 psi for wall thicknesses of 12/32 to 7/16-in.

46,000 psi for wall thicknesses of 7/16 to 1/2-in.

Assuming a factor of safety, referred to yield strength, of 1.56 for all sections, except that of the Milpitas district where the factor was increased to 2.44, a tapered line was laid out. The volume delivered at Milpitas was considered to be 420,000,000 cu ft per day and the assumed temperature to be 60 F. Consideration was also given to a static condition of the line, which is affected by density of gas and elevation of the line subject to modification of the pressure limiting stations.



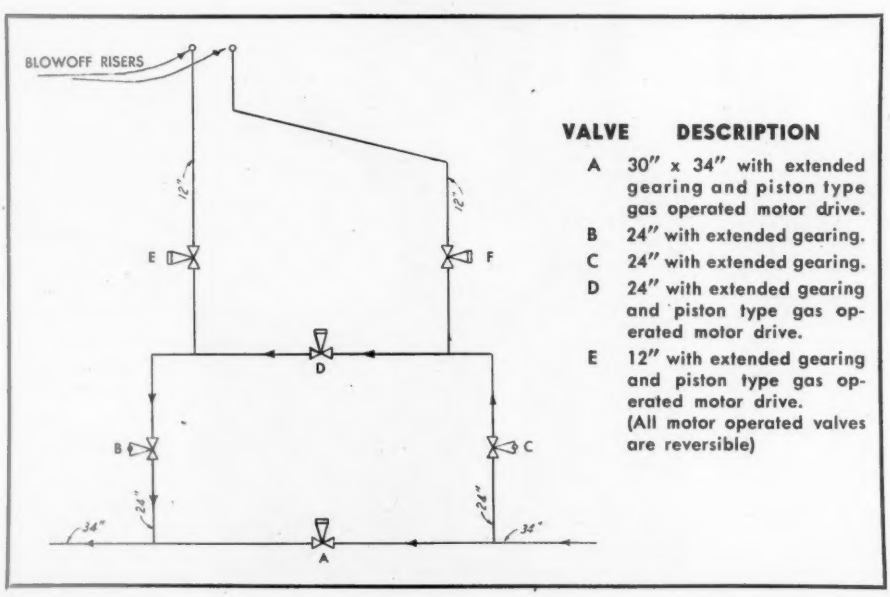
Roll down rails at the "double ending" plant. The pipe is rotated by electrically driven rolls for welding convenience. View shows first bead application.

In design of the line, 7/16-in. wall pipe is used with approximate gas pressures of from 800 to 675 psi; 11/32-in. or 3/8-in. thickness, from 675 to 610 psi; 5/16-in. from 610 psi to minimum pressure.

Topography gives rise to some critical pressure changes, the most severe case being that of crossing the Tehachapi range at an elevation of about 5000 ft and falling abruptly, within 7 miles, to the San Joaquin Valley level of 500 ft. This drop of 4500 ft with the gas at normal operating pressure and temperature accounts for about a 100 psi pressure increase.

New compressor stations are to be situated at Topock and Hinkley. Additional facilities will be added to a present station at Kettleman. Seven pressure limiting stations will be installed. The accompanying chart shows a diagram of the pressure limiting scheme. Under normal conditions gas flows through the open 30-in. Valve A, and through the 24-in. shunt line with Valves B, C, and D fully open. If a pressure differential occurs so that the pressure down line approaches to within 10 psi of the allowable pressure of the down line section, Valve A closes automatically, thus restricting the flow. If the pressure still increases, Valve D further throttles the flow, and if necessary, completely closes while blow-off Valve E opens to the atmosphere until pressure is returned to within allowable limits. All these operations are automatic. Valve F on upstream side will also automatically open to atmosphere if pressure on that side approaches too close to the maximum allowable limits on the upstream side of the line. Valves B and C are hand operated and used in emergencies only.

At 10-mile intervals between compressor stations are placed main line valves, hand operated but with provisions for motor installation if needed. Blow-off valves, 12-in., are placed on each side of the main line valves. To facilitate bleeding of the line, 12-in. blow-offs are installed at the half-way point between each of the main line valves. * * *



VALVE	DESCRIPTION
A	30" x 34" with extended gearing and piston type gas operated motor drive.
B	24" with extended gearing.
C	24" with extended gearing.
D	24" with extended gearing and piston type gas operated motor drive.
E	12" with extended gearing and piston type gas operated motor drive. (All motor operated valves are reversible)

P 615.36

Microwave Radio Relay System

Keystone installs pulse time multiplex equipment in Pennsylvania, first of its kind in pipe line operations

J. D. MUNTON*

THE Keystone Pipe Line Company, a subsidiary of the Atlantic Refining Company, has become the first pipe line operator to use a microwave radio relay system for communication. A microwave pulse time multiplex radio relay in the range of 1850-1950 megacycles, providing facilities for continuous unattended telephone, telegraph, telemetering, and remote control service on one RF channel, has been installed for Keystone in eastern Pennsylvania by Federal Telephone and Radio Corporation, Clifton, New Jersey, manufacturing associate of International Telephone and Telegraph Corporation, and Federal Telecommunication Laboratories, IT&T research associate.

This latest installation of the Federal PTM (pulse time multiplex) system features an ultimate capacity of 23 speech channels, each including duplex equivalent d-c signaling channels for ringing or dialing. Although originally designed for 23 channel operation, this system is also engineered for 8 channel ultimate grouping or with stackable channels as may be required. At present only 5 channels are being used in this installation with the remaining potential reserved for future expansion.

The pipe line served by this radio relay lies between Philadelphia and Montello, a distance of 60 miles. At Montello, the system ties in with existing wire lines extending to both Pittsburgh and Buffalo, the two terminals of the pipe line. The sector between Philadelphia and Montello was previously served by wire line facilities leased from a wire line company.

Utmost reliability is considered a major factor in the selection of a pipe line communication system because of the nature of this type of operation. The Keystone Pipe Line Company, acting as a common carrier, pumps liquid petroleum products through two lines, one of 8 in. diam, the other of 12 in., from a refinery at Point Breeze, Philadelphia, to Pittsburgh on the west line and Buffalo on the north line. These lines, operating at pumping pressures of approximately 1000 psi, have pumping stations at approximately 30-mile intervals. It is these stations that maintain delivery schedules of products, either to the end of the line or to any designated storage depot along the line.

Indicative of the need for dependable communication is the practice of each pump station to report to the dispatcher every half-hour in a staggered system, 24 hr a day, giving data on volume, pressure, and product passing that point during the past half-hour. The dispatcher, in turn, orders the pump station attendant to change his delivery rate, divert products for storage or delivery at his location, or take his pump off the line.

In addition to these normal dispatching functions, there is the ever-present danger of rupture in these high pressure lines carrying explosive petroleum products. A completely reliable communication system is of great importance, therefore, to provide warning of pressure changes tending toward rupture and to permit prompt action in minimizing the damage when such emergencies do occur.

Installation Sites

Before a microwave relay can be considered as a communication system between two points, the possibility of establishing a reliable line-of-sight path between these points must be investigated. This must be dealt with not only from the viewpoint of the propagation of microwaves, but also from the viewpoint of economy, availability of land, and the availability of power and access roads to the sites.

As projected, the Keystone installation had to provide traffic circuits between the central office of the Atlantic Refining Company at 260 South Broad Street, Philadelphia; the Boot Pumping Station near Exton, Pennsylvania (a distance of 20 miles), and the Montello Pumping Station at Sinking Springs, Pennsylvania (approximately 36 miles from Boot).

The first consideration was the choice of probable repeater sites from a study of topographical maps of the region. Due to the nature of the terrain, the three locations could not be linked directly without the use of prohibitively high towers. The radio path extends approximately east and west. This path is cut by a series of parallel ridges running northeast and southwest, and whose elevations increase progressively in the direction of Montello. Looking west from Philadelphia, the first ridge has an elevation of approximately 300 ft; the second, approximately 700 ft; the third, approximately 800 ft; and the fourth, approximately 1000 ft. A further complication is the fact that each pumping station lies in a valley behind one of these ridges, thus putting them in the shadow of a radio beam from Philadelphia. The elevations of the points to be linked are:

The Atlantic Refining Building—310 ft above datum level.

Boot pump station—570 ft above datum level.

Montello pump station—480 ft above datum level.

Several peaks were selected in the vicinity of the Boot pump station, which could provide a line-of-sight path to both Philadelphia and Boot.

The ultimate choice was a peak near Valley Forge, approximately 8 miles from the Boot pump station. This peak is shown on the topographical maps as an elevation of 680 ft. (An independent survey proved the actual elevation to be 650 ft . . . the geodetic map being in error by 30 ft). A profile of the terrain shows that this altitude of 650 ft would necessitate a tower approximately 170 ft high to provide Fresnel zone clearance over the intervening ridge at Bryn Mawr to the roof of the Atlantic Building. Actually, the necessary clearance was obtained by use of a 150-ft tower (to minimize the expense of complying with CAA regulations) and by adding a 40-ft structure to the top of the Atlantic Building. The profile toward the Boot pump station showed that any height sufficient to

†Manager of Communications, Keystone Pipe Line Company.

FIG. 1. Simplified block diagram of the Federal PTM microwave radio relay system installed for Keystone Pipe Line.

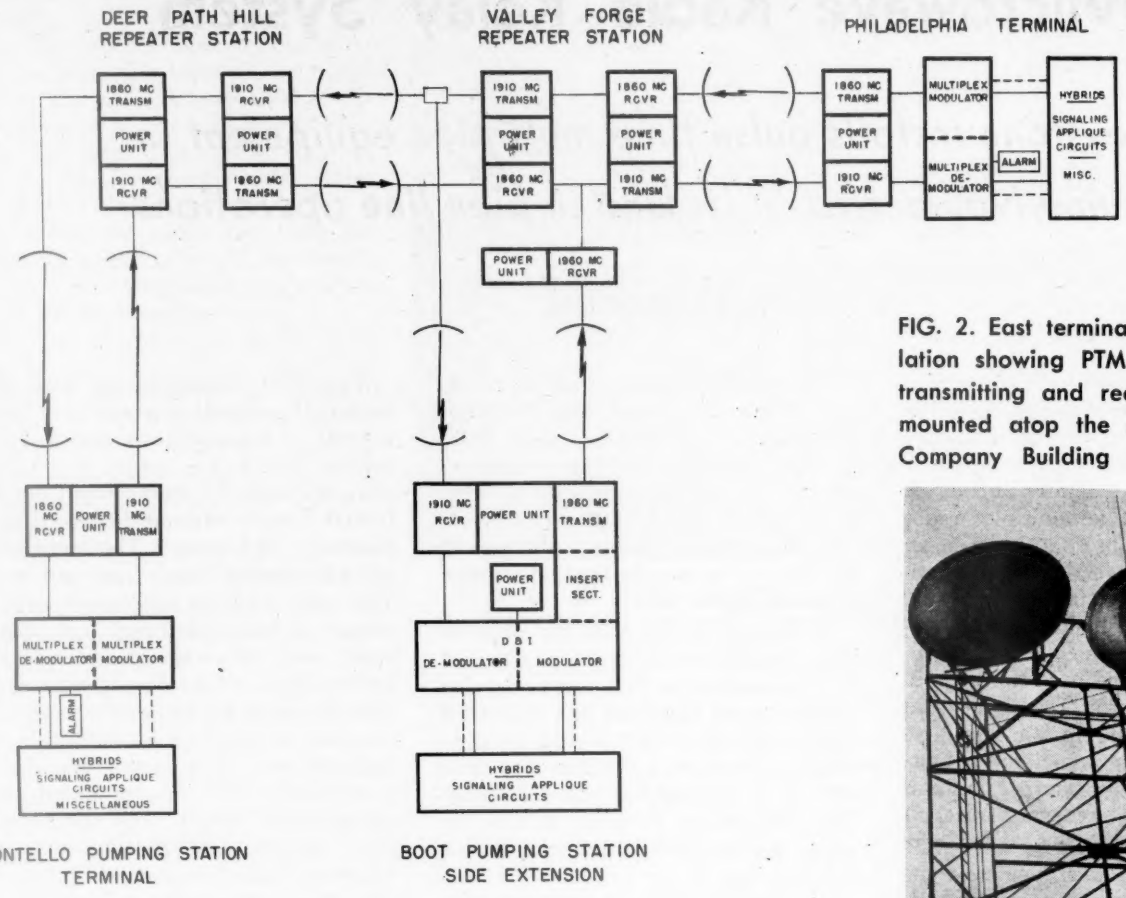
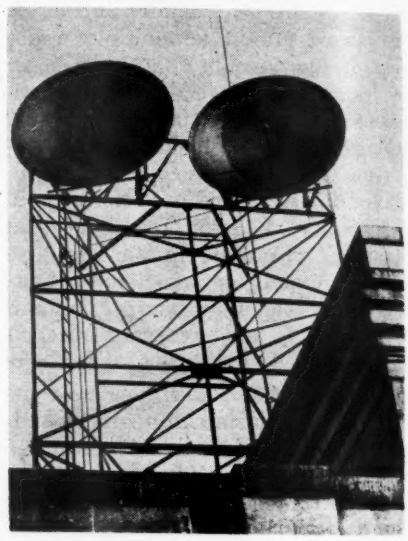


FIG. 2. East terminal antenna installation showing PTM 10-ft parabolic transmitting and receiving antennas mounted atop the Atlantic Refining Company Building in Philadelphia.



clear local obstacles (trees, buildings, etc.) would provide the necessary Fresnel zone clearance. As the trees in the vicinity have a height of 75 ft, a 100-ft tower at Boot was indicated.

The location of Montello (elevation 470 ft) behind a ridge (elevation 1000-1200 ft) eliminated the possibility of beaming directly from the Valley Forge repeater to the pumping station. A second repeater site had to be chosen. This site not only had to provide a line-of-sight path to the pumping station and to Valley Forge, but also had to be strategically located so that the relay could be extended to the west in the future.

Several points meeting these requirements were found after careful study of the topographical maps. One site fell in the middle of a municipal park, hence was not available; and a second could not be purchased or leased. Therefore, the third site, atop Deer Path Hill, overlooking the city of Reading, was chosen. This lies in the fourth ridge, mentioned above, at an elevation of 1100 ft. A 100-ft tower was necessary to clear trees, provide line-of-sight toward Valley Forge and establish a suitable height for future expansion to the west.

The Montello pump station lies in the Reading Valley, approximately 6 miles to the west of Reading at an elevation of 470 ft. The pump station is visible on a clear day from the Deer Path Hill tower. A 60-ft tower at the pump station provides sufficient clearance above the local trees.

A section of the link from the Atlantic Building to the Valley Forge repeater and to the Deer Path Hill repeater form the backbone of the system (Fig. 1). The Boot and Montello pumping stations are side extensions. The Montello station is the present west terminal of the relay, with complete terminal facilities. As the system is extended, Montello will become a way-station, similar to the Boot station.

Equipment Installations

The advantages of operation in the frequency spectrum utilized in the system installed for Keystone become apparent when the matter of locating the radio equipment with respect to the antennas atop the towers was considered.

When RF equipment must be mounted in close proximity to the antennas on the towers, substantial costs are incurred in providing towers that will bear this added load. Furthermore, maintenance and inspection of such tower-top installations constitute a hazard and inconvenience to personnel, particularly in inclement weather.

These undesirable factors were eliminated in the Keystone project because the 2000-megacycle region in which the equipment operates enabled the RF, multiplex, and relay or terminal equipment to be entirely housed in a single building at the base of each tower, without incurring excessive transmission line losses. Having all components except the antennas in a single building also eliminates potential trouble-spots that could result from the interconnection networks required when portions of the radio and terminal or relay equipment are located in separate structures.

Air-spaced, 52-ohm, copper coaxial line, $\frac{7}{8}$-in. diam, with an attenuation of 2 db per 100 ft, was used where transmission line distances exceeded 60 ft. For shorter distances, solid dielectric coaxial cable (RG-17/U) was used.

In all cases, the radiating and re-

ceiving dipoles are mounted at the foci of parabolic reflectors which concentrate the beam. The power gain over a simple dipole is proportional to the diameter of the parabola. Calculations made for received signal strength at Valley Forge and Deer Path Hill, after including the losses due to path attenuation and transmission line losses, indicated that 10-ft parabolic reflectors would give sufficient gain over these paths for satisfactory operation, even with fades as deep as 30 db. The short side paths (8 miles to Boot and 6 miles to Montello) need only 6-ft reflectors for the same service.

The dipoles are enclosed in plastic housings to minimize rain and snow effects and, together with the transmission lines, are pressurized with dry air. An automatic pump and dehydrator system maintains this pressure at a minimum of 5 psi above atmospheric.

With respect to the antenna system, the installation described here utilizes a separate parabolic antenna for each RF transmitter and each RF receiver. When desired, an optional type installation permits this same transmission to be accomplished by using only one parabolic antenna for both the transmit and receive RF paths. This is accomplished by using an appropriate filter in the transmission line.

Philadelphia Terminal. The Philadelphia terminal has two 10-ft antenna assemblies mounted side by side on a 40-ft extension atop the Atlantic Building (Fig. 2). These parabolas provide a gain of 34 db over a point source, and transmit a beam approximately 5 deg wide. At installation, the antennas were oriented with the aid of a regular surveyor's transit and geodetic maps. The result was calculated as orientation within half a degree of optimum. Final orientation was accomplished through parabola adjustment to give a maximum received radio signal. This final adjustment was made with the parabolas' vertical plan pivot and turnbuckles, which permit a 5 deg swing in azimuth.

It has been found that a final adjustment in elevation is most often not required since the usual difference in elevation between two sites is 1000 ft at most. In 30 miles this differential produces a negligible small angle. With the parabolas set at a true horizontal and a 5 deg transmitting beam spreading to about 2 miles at a distance of 30 miles, the receiving antenna will lie in the beam in the vertical direction in all but the most extreme cases.

The antennas at Philadelphia are connected to the radio equipment, which is housed on the 22nd floor directly below the tower, through air-space coaxial line. The video side of the radio equipment is in turn connected by solid dielectric coaxial cable to the multiplexing and termination equipment on the 13th floor. This latter equipment is located in a room with the private automatic exchange that services the company offices.

Valley Forge Repeater Station. The Valley Forge repeater uses a 150-ft triangular steel tower and a concrete house for equipment at the base of the tower. This tower mounts four 10-ft and two 6-ft parabolas. Two of the 10-ft assemblies are directed toward Philadelphia and the other two toward the Deer Path Hill repeater station. The two 6-ft parabolas are directed toward the Boot pumping station, 8 miles away and approximately 60 deg south of the beam to Deer Path Hill.

The building at the base of the tower houses the radio repeater equipment and also an emergency power source. The latter equipment consists of an inverted rotary converter and a bank of storage cells, arranged for automatic cutover in case of power failure. A gasoline engine generator can be started by maintenance personnel in the event of prolonged outage. This emergency equipment also supplies the tower aircraft warning light system, in compliance with CAA regulations. Extremes of temperature in the equipment building are avoided by the inclusion of an automatic heating and ventilating system.

In routine operation, this station is entirely unattended.

Deer Path Hill Repeater Station. The Deer Path Hill repeater station, also unattended, is almost a duplicate of the Valley Forge Repeater. The principal difference is that it utilizes a 100-ft rectangular tower, supporting, at present, two 10-ft parabolas directed toward Valley Forge and two 6-ft parabolas directed toward Montello (Figs. 3 and 4). The tower has provisions for mounting six additional 10-ft parabolas for future expansion of the system to the north, west, and south.

Boot Pumping Station Side Extension. The Boot pumping station installation has a 96-ft tower, mounting two 6-ft parabolas oriented to the Valley Forge repeater station. The radio equipment is housed in a fireproof concrete house at the base of the tower. Audio extension lines interconnect this building with the pumping station proper and the storage depot at nearby Exton. Although the pumping station is continuously manned the communication equipment operates on an unattended basis with alarm indication extended into the pump house.

The circuit from Philadelphia to Boot is a drop and insert channel via the Valley Forge repeater. It serves as a party line facility and is connected to the dispatch party line channel at Philadelphia. In connection with this type of service provisions can be made for separate marker pulse generators for independent station-to-station operation in lieu of connection to the main pulse generator at system terminals. This is recommended for extended systems where section operation may be required due to failure of intermediate repeaters. It was not considered necessary to include this provision in the Keystone installation as only two repeaters are involved in the present system.

Montello Terminal Station. The Montello terminal of the relay system, situated on company grounds, utilizes a 60-ft tower with two 6-ft parabolas (Fig. 5). At this point two channels are connected to the existing physical dispatching circuits for the west and north lines; a third channel is extended as a through message circuit to Pittsburgh over a Federal 9-A-1 carrier telephone channel; and the fourth circuit provides a Philadelphia-Montello message circuit (Fig. 6).

Description of Equipment

Pulse Time Multiplex Principles. Pulse time multiplex is a system for transmitting many channels of communication over a single medium. This can be a radio frequency circuit or a coaxial cable, either of which must be capable of transmitting a rapid sequence of distinct, short pulses. Unlike frequency division systems, in which all channels are transmitted continuously and simultaneously, this is a time division system in which information is sent for only one channel at a time. This factor removes a severe limitation from the radio frequency equipment in that it need not have a linear characteristic.

Each channel is transmitted by sending a series of samples taken at a rapid rate. This sampling, or scanning rate, must be at least 2.3 times the highest frequency of channel content to be reproduced. Thus, for a 3400-cycle upper limit, a scanning rate of 8 kc is indicated. One single idle channel is thereby represented by a series of equally spaced pulses 125 microseconds apart.

Modulation of the channel causes the pulses to deviate from their nonmodulated median positions in time—to appear earlier or later in accordance with the modulating signal. Maximum modulation thus displaces the channel pulses forward and back-

ward in time to the greatest degree permitted by the system design. The rate at which pulses are displaced depends upon the frequencies in the channel signal.

Transmission. In the PTM equipment described, 23-channel capacity is achieved by dividing the 125-microsecond interval into 24 equal parts, each being 5.2 microseconds in duration. A pulse is transmitted during each of these 24 segments. The first segment contains the unvarying marker pulse. This is made distinctive by using 2 pulses spaced 1.3 microseconds apart. The marker pulse gives a time reference by means of which the demodulating equipment can separate and demodulate the channels. The single pulses of the 23 channels occupy the remainder of the segments.

The introduction of crosstalk into each following channel is avoided by making the pulses so short that they die away with no significant remainder left to affect the next pulse. The pulses used in this system are 0.5 microseconds long. As demodulation depends upon the leading edge of the pulses, they are shaped to rise to their maximum in 0.15 microseconds—thus minimizing noise.

Modulation. It is simpler to generate modulated pulses considerably broader than 0.5 microseconds in the modulating process and shorten them later. Accordingly, the channel modulators are placed in three groups. The first group contains the eight modulators for channels 1, 4, 7, through 22; the second group contains eight modulators for channels 2, 5, 8, through 23; while the third group contains seven modulators for channels 3, 6, 9, through 21. The time represented by the missing channels in each group allows for the broad pulses without causing crosstalk.

The pulses for each group are combined by a mixer-shaper circuit, which shortens the pulses to make room for those of the other two groups. The pulses from all three groups are mixed and further shaped in the mixer-line amplifier. This circuit also generates and adds to the marker pulse.

The pulses generated by each channel modulator are made to occur in the proper sequence for interleaving by sending short pulses at the 8-kc rate into a delay line commutator. This commutator has 23 taps, spaced 5.2 microseconds apart, with each tap connected to a different modulator so that they operate in sequence—one after the other.

The mixer-line amplifier has an output impedance of 70 ohms, with sufficient power to modulate the radio transmitter over as much as 2000 ft of solid dielectric video cable (RG-11/U.)

Reception-Demodulation. The received PTM signals are applied to the demodulating equipment as video pulses. They are first passed through amplitude limiters and differentiated to remove amplitude noise. The marker pulse is identified by its double pulse characteristic and used to generate an 8-kc pulse. This pulse, approximately equal in length to the period allotted to an individual channel, is used to change each channel demodulator, in sequence, from a normal blocked condition to a receptive condition. This is accomplished by sending the de-blocking pulses into a delay line commutator similar to that used in transmitting.

Part of the de-blocking pulse emerges from the delay line at each 5.2 microsecond tap, each of which is connected to a separate demodulator. The incoming pulses for all channels are applied to every demodulator continuously, but only the particular demodulator activated by the de-blocking pulse can interpret the pulses received, and the timing permits demodulation of only the proper channel pulse.

Transmitter Equipment. The PTM transmitter consists of a 3-stage video amplifier, modulator, and microwave oscillator. The video signal from the multiplex modulator is applied across the input of the transmitter and amplified and shaped in the video amplifier. The oscillator, using a planar electrode triode (type 2C43) operating in a cavity of the re-entrant grid bell

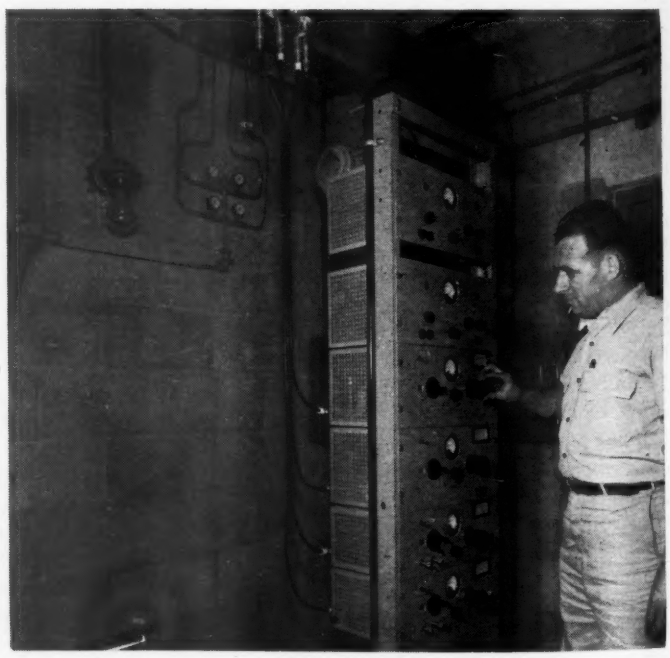


FIG. 3. Left, Deer Path Hill repeater station. Parabolas on left face of 100-ft tower are directed toward Valley Forge repeater station; parabolas on rear toward Montello.

FIG. 4. PTM radio repeater equipment installed at Deer Path Hill repeater station. Shown are the two transmitters, two receivers, and associated power supplies comprising the normally unattended radio repeater installation.

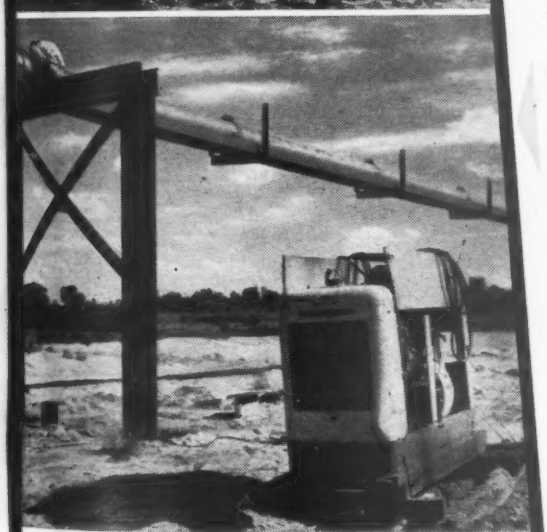
One kind of power *for all kinds of jobs!*

DITCHING

It's duck soup for this unit! A "Caterpillar" Diesel D13000 powers the Buckeye 51 ditcher digging trench near Bassfield, Mississippi. Owner: Wunderlich & Griffis Construction Co., Tulsa, Oklahoma.

EXCAVATING

No time wasted here! A "Caterpillar" Diesel D318 Engine powers the Lorain dragline with clamshell bucket that keeps things moving on this pipe-line job near Hollister, Calif. Owner: Bechtel, Price, Conges, San Francisco.



WELDING

Tough machines for tough service! "Cat"-powered G. E. Electric Welders, like this set pictured in use near Garden City, Kansas, make a great team. Owner: Pittsburgh-Des Moines Steel Co., Des Moines, Iowa.

AIR DRILLING

Steady does it in any kind of going! A "Caterpillar" Diesel D13000 Engine powers the Gardner-Denver compressor working on this gas-line project near Wartburg, Tenn. Owner: Oman, Fulton, Brodie Co., Nashville.

THE four different machines shown here doing four different pipe-line jobs have one thing in common. They're all "Cat"-powered. Built for rugged service, "Cat" Diesel Engines are compact, portable, dependable. Precision-engineered, they're fool-proof and foul-proof. They team up with other machinery to deliver money-saving performance. Standardize on them and you have a setup that can't be beat for real economy.

Next time you're in the market, specify "Cat" Diesel Engines on your equipment orders. Available in the machinery of leading manufacturers, they'll deliver the reliable power needed to make profits. Want proof? Your "Caterpillar" dealer has hundreds of records of their performance on actual jobs. He's as close as your phone for information or service—call him today!

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FIG. 5. Present western terminal of the Keystone Pipe Line Company's installation of PTM microwave radio relay at Montello, Pennsylvania. Terminating equipment is housed in the building at base of 60-ft tower.

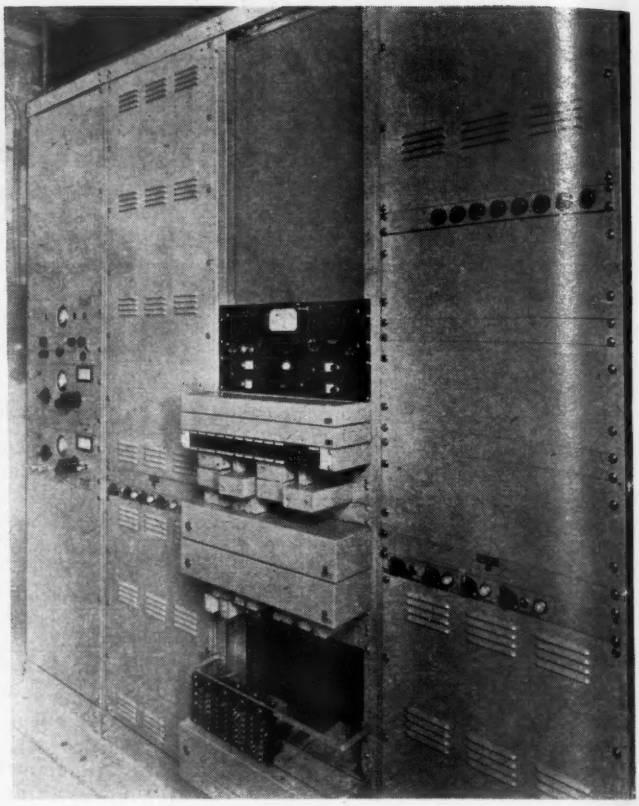


FIG. 6. Terminal installation at Montello. Equipment Bays are, left to right: for (1) RF; (2) demodulating; (3) miscellaneous signaling and voice terminating; and (4) modulating equipment.

type, provides extreme circuit simplicity with a maximum stability.

The output of the transmitter, a series of RF pulses, is applied through a transmission line to the antenna.

Monitoring facilities for output power and pulse characteristic observation are incorporated in the transmitter. A self-contained relay to operate alarm circuits and automatic switchover equipment is controlled by the power output monitor.

Receiving Equipment. In the PTM receiver, which is of conventional superheterodyne design, the local oscillator utilizes a Type 2C43 planar electrode triode operating in a cavity similar to that used in the transmitter. A coaxial cavity crystal mixer, a 30-megacycle intermediate frequency amplifier and a video output stage comprise the remainder of the receiver. A self-contained meter and switch afford complete monitoring of receiver currents and voltages, while a precision invar cavity wave meter provides a secondary standard for checking local oscillator frequency.

Multiplex Modulator Equipment. The multiplex modulator equipment is comprised of a base frequency crystal-controlled pulsed generator, delay line commutator, modulators, mixer shapers, and mixer-line amplifier.

Two-Wire Operation

The voice channel sides of a PTM channel modulator and a channel demodulator are connected to give ordinary two-wire telephone circuits by a 4-wire terminating set, including hybrid coils. This arrangement is similar to that used in carrier telephone and 4-wire voice circuits to join a 2-way circuit with two 1-way channels.

Signaling or dialing associated with the telephone circuit is separated and recombined by suitable ringers or dialing repeaters, using the equivalent d-c signal of PTM to pass the signals over the system.

D-C Signaling

The equivalent of d-c signals are transmitted over PTM channels by displacing the channel pulse to a forward position. This forward displacement is repeated on each pulse throughout the duration of the signal. In the demodulating equipment this pulse is detected and applied to a relay.

In the Keystone installation, this equivalent d-c signaling is used to transmit dialing, ringing, and railway selector impulses. It is also available for telemetering and supervisory indications.

Railway Selector Operation

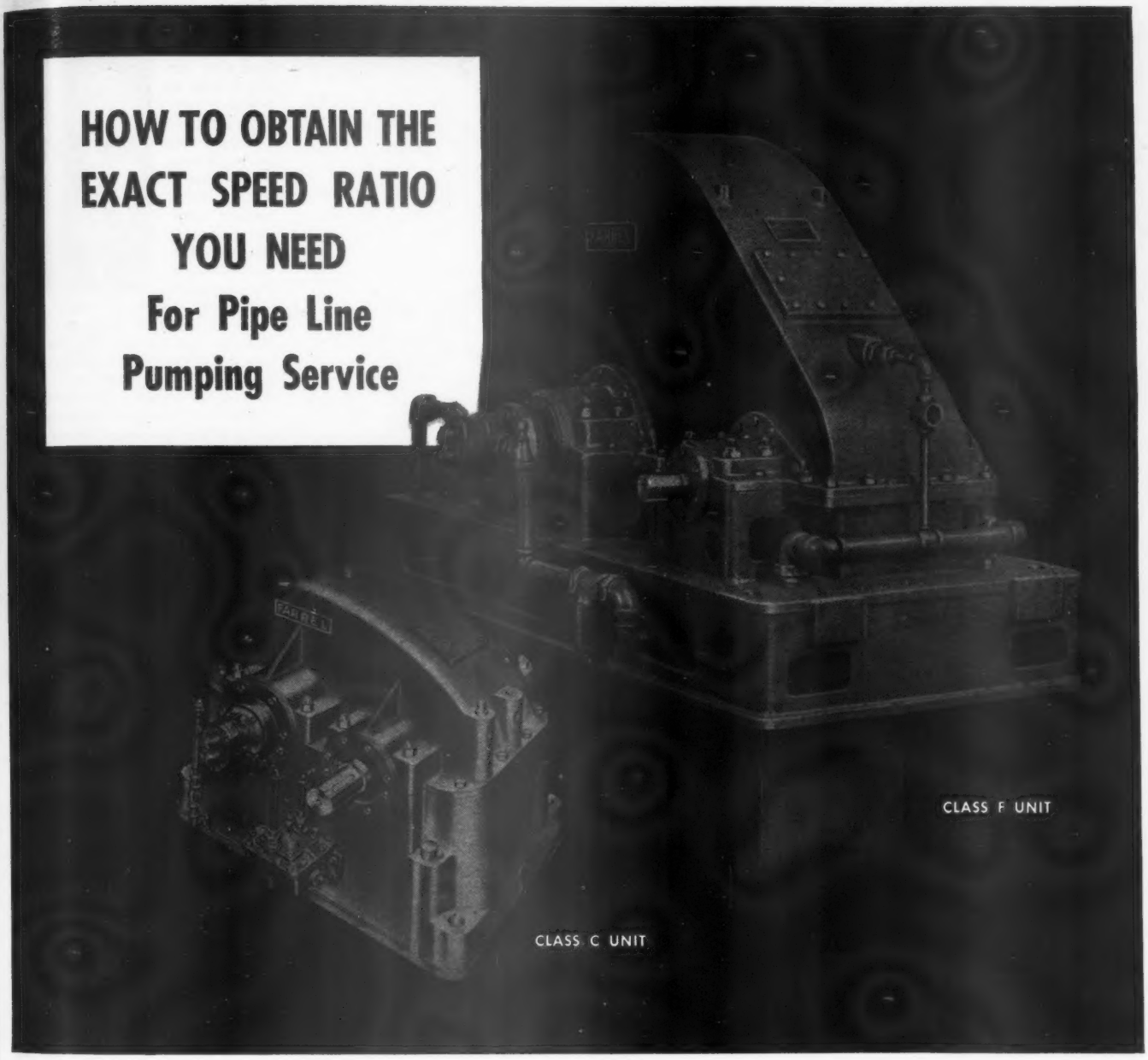
An important requirement of the Keystone microwave system was that it must function as an intermediate link in a wire system utilizing Western Electric Company railway selectors, with impulse sending equipment at a number of locations on either side of the radio section.

This function required reception of 3½ to 5-cycle polarized impulses at d-c voltages up to 300 volts or more, sending them over the PTM as on-and-off signals and then reproducing similar high voltage polarized impulses for application to the physical line at the other end of the radio system. This operation is required in either direction as signals are received.

To meet these requirements, polarized relays are provided to pick up the pulses from the line and various time delay circuits are incorporated to insure performance in one direction at a time without undesired kickbacks in the reverse direction.

The d-c signal is used to control standard railway selector apparatus cases and line rectifiers for transmitting the signal to the outgoing physical line. At points where no physical line extension is required, such as the North Line dispatcher at Philadelphia, the dispatcher's selector key is connected on a simple d-c basis to the PTM modulator signal sending circuit. A simple capacitor charge and discharge circuit is used to operate the railway selector set directly from the received d-c signals. * * *

HOW TO OBTAIN THE EXACT SPEED RATIO YOU NEED For Pipe Line Pumping Service



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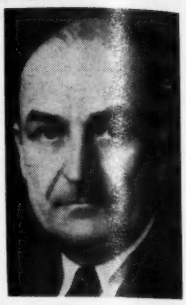
Odorizing Natural Gas

ROBERT M. HUTCHISON

The Author



R. M. Hutchison is an alumnus of Pennsylvania State College where he received the degree of B. S. in metallurgical engineering. He has been connected with the gas industry for 25 years and is now director of research and safety for the Houston Natural Gas Corporation. He is the inventor of the "Hutchison Calculator" and the "H & H Odorizer." He is a member of Sigma Chi Fraternity and Tau Beta Pi Engineering Society; belongs to the National Society of Professional Engineers, the American Society of Safety Engineers, and is vice president of the Engineers' Council of Houston. He is also a member of the Houston Engineers Club and served two terms as its president.

As early as 1920 thought was being given to the odorization of natural gas, so it would hardly be fitting to treat the subject as something that the cat just dragged in, even if most of the gas odorants do seem to denote such an act on the part of kitty. Neither would it be in order to suggest that a gas odorant should be other than an obnoxious smell, for odorization is primarily a safety measure designed to promote immediate action, and if a whiff of "My Sin" or "Midnight Rose" gently touched the olfactory nerves when a gas leak were present the casualties from gas explosions would no doubt be increased rather than diminished.

It is therefore safe to say the pioneers in the practice of gas odorization knew what they were doing when they expounded the value of, shall we say—"the emphatic stenches?"

It can further be said that the manufacturers must have known it also, because never during the 29 intervening years has a product been offered that in any way gladdened the nose.

The odorants most generally used have a sulphur base and are therefore similar in smell to a degree, but their physical and chemical properties differ and thereby hangs a tale.

Odorization is practiced under a wide divergence of conditions. It is being done at both high and low pressure, at sub zero temperature, and when the thermometer registers 100 F or more. Some of the gas being odorized may be called dry, but a large amount may be termed wet; and some companies who use natural gas for reforming are now endeavoring to impart an odor to varying mixtures of natural and manufactured gases. In addition, efforts are being made to odorize gas volumes that vary from a consumption as low as 5 cu ft an hr to those reaching far into the millions.

Two types of odorizers have been rather generally employed. One, the drip type, is more suitable for large gas volumes and concentrated odorants. The other, the absorption type, is more generally used with smaller volumes and both dilute or concentrated odorants. There are many variations in the construction of the two types and naturally some will give better results than others. Certain difficulties have been experienced in the use of both types of equipment, such as flooding the system, plugging of odorizer orifices, float valve trouble, foreign matter or slush clogging the filter, accumulation of heavy ends in the odorizer, overheating where heating elements are in use, dust accumulation on wicking used in some absorption types, leaking fittings, etc. Such troubles are not peculiar to all odorizers but, as some are common to both, an effort has been made to build an odorizer that will eliminate as many of the headaches of both types as possible.

For many years engineers have wanted an odorant with a constant boiling point, because such a product would eliminate the heavy end trouble, and, although one is in the offing, there will always be room for an odorizer that will process any type of odorant.

This has been accomplished in the new type odorizer to be described herein, but before proceeding to do so reference will be made to certain laboratory tests that were made to determine the strength of the most generally accepted odorants.

According to the Odorization Law of Texas, "gas shall be given an odor by adding an agent that will vaporize, dissolve in or be so diffused with the gas as to produce an odor readily perceptible to normal or average olfactory senses of a person coming from fresh, ungasified air into a closed room or space when gas is present in air in concentrations of as much as one part gas to ninety-nine parts air in said closed room or space." The writer has conducted or witnessed many room tests to determine odor concentration but no test has ever been made where it was necessary to have 1 per cent of gas present before the odor was detected.

For this reason it was decided to determine what the minimum odor concentration of various odorants in a room could be and still fulfill state requirements. Consequently, standard solutions were prepared and room tests made using odor concentrations varying from 0.05 to 0.8 lb per million cu ft of gas.

These tests prove conclusively that odor concentrations of from 0.2 to 0.5 lb of concentrated odorant per million cubic feet of gas odorized, the amount of the concentration depending upon the particular commercial odorant being used, would be readily perceptible in a room when the odorized gas was present in the amount of one per cent of the net cubic feet of room volume.

This does not mean that injection rates of 0.2 to 0.5 lb of odorant at a town border station or in a main line would assure the same odor strength in a building but it serves as a yardstick for establishing an odorization rate. It is quite likely, however, that an injection rate of 0.75 lb concentrated odorant per million cubic feet of gas will guarantee satisfactory odorization in a majority of plants.

A safe method of determining the rate would therefore seem to be as follows:

Start odorizing at a 0.75 lb per million cubic feet rate when using a concentrated odorant and after scattered room tests have proved satisfactory; reduce the concentration gradually to the point where room tests still indicate a safety factor of not less than 3. Along with these tests an effort should also be made to determine whether the concentration being used will indicate outside leaks, because this is a distinct advantage in an odorization program and should not be overlooked.

Earlier in this article reference was made to both the drip and absorption type odorizer and certain difficulties that have been experienced in the use

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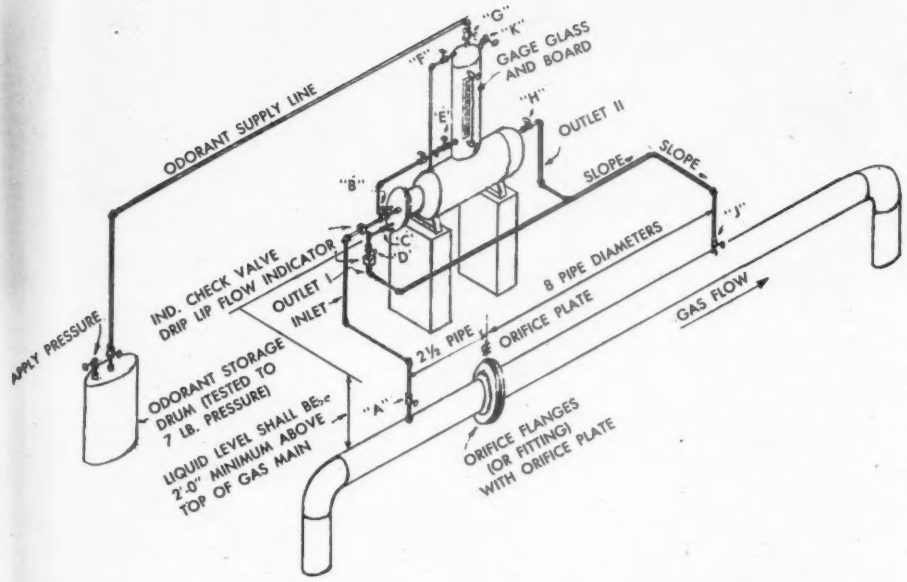


Method of connecting odorizer to gas pipe line.

of one or the other. In designing a new piece of equipment it would therefore be natural to combine the advantages and discard the disadvantages of those presently being used if such were possible. One of the chief difficulties experienced in the absorption type odorizer is the accumulation of heavy ends, so odorants being as they are it was decided to eliminate this trouble as the major premise. Consequently, the H & H combination drip plus absorption type odorizer was developed. Its features may be listed as follows: (1) A float valve is its only moving part; (2) It cannot flood the system; (3) It contains no wicks to become clogged; (4) Heavy ends do not accumulate in the absorbing chamber; (5) It will work on any of the generally accepted odorants whether dilute or concentrated without any change other than valve adjustments; (6) It does not depend on electric power; (7) It has no heating elements; (8) It is automatic in operation and is actuated by the differential across an orifice in the main line; (9) It can be built to accommodate practically any operating condition, and has a broad capacity range; (10) Stoppage of odorization is practically impossible; (11) It will maintain its rate within a practical range without heating elements; (12) Odorization is not interrupted at the time of filling; (13) If distillate accumulates in the absorbing chamber, it can be drained away.

The following is a monthly statement of the operating results of one of these odorizers, which is installed in the open and has been subjected to temperature changes from 20 to 100 F and pressure changes varying from 130 to 155 psi.

1949	Monthly rate, lb per million
February	0.81
March	0.85
April	0.86
May	0.80
June	0.79
July	0.78
August	0.79
September	0.80
October	0.90

The delivery through this station varies from 18,000,000 to 36,000,000 cu ft per day.

In operating the odorizer the dripper is first set to maintain the desired odor concentration at minimum flow, at which time the differential across the orifice should be practically zero. Then, with the bypass valve in the odorizer properly adjusted, gas will be bypassed through the absorption chamber in proportion to the main line flow and thus the desired odorizing rate will be maintained. When once adjusted little further attention is needed, except possibly to change the size of the orifice as the load fluctuates between summer and winter.

A gradual opening of the bypass valve will compensate within practical limits for a decrease in temperature. In extremely cold climates, however, it is no doubt necessary to place any type of odorizer inside a heated building, so such a course applies to this piece of equipment also.

The sketch that accompanies this article is a diagrammatic drawing showing a typical installation of one of these odorizers. A little study of the arrangement will be sufficient to acquaint the reader with its simplicity.

The horizontal tank is equal in size to the upper or storage tank so that if for any reason the float failed to hold the liquid odorant would be caught in the bottom and later returned to the storage tank above. It is interesting to note, however, that the odorizer would continue to function and the liquid would not be dumped into the main line.

The sketch also shows the method used to fill the storage tank from an

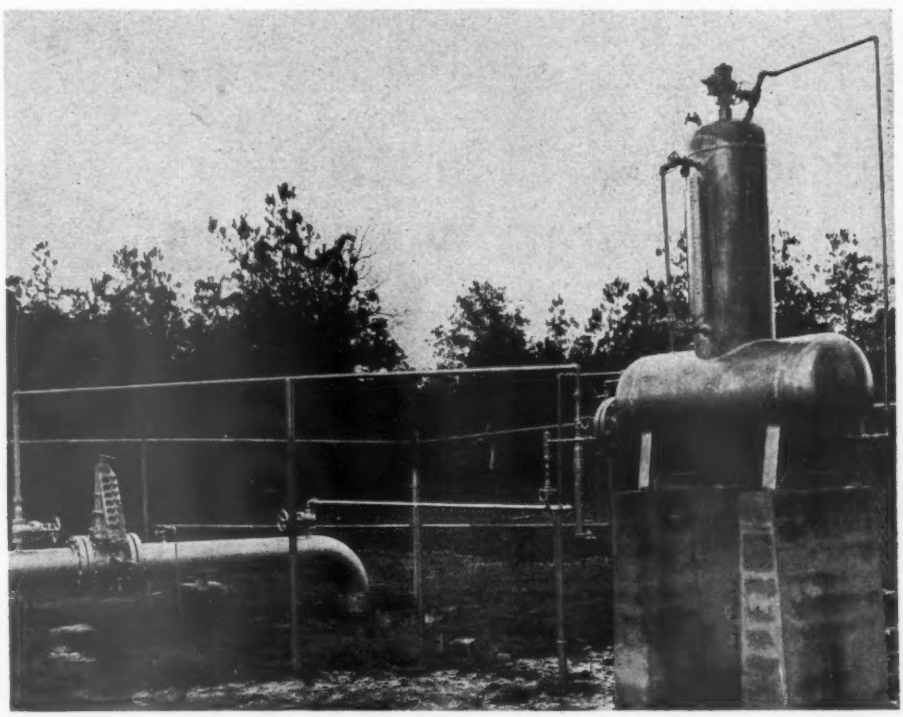


FIG. 1. Check valve and drip lip indicator.

odorant drum. After closing the necessary valves on the storage tank the pressure is relieved and the odorant is then blown from the storage drum into the tank with gas pressure.

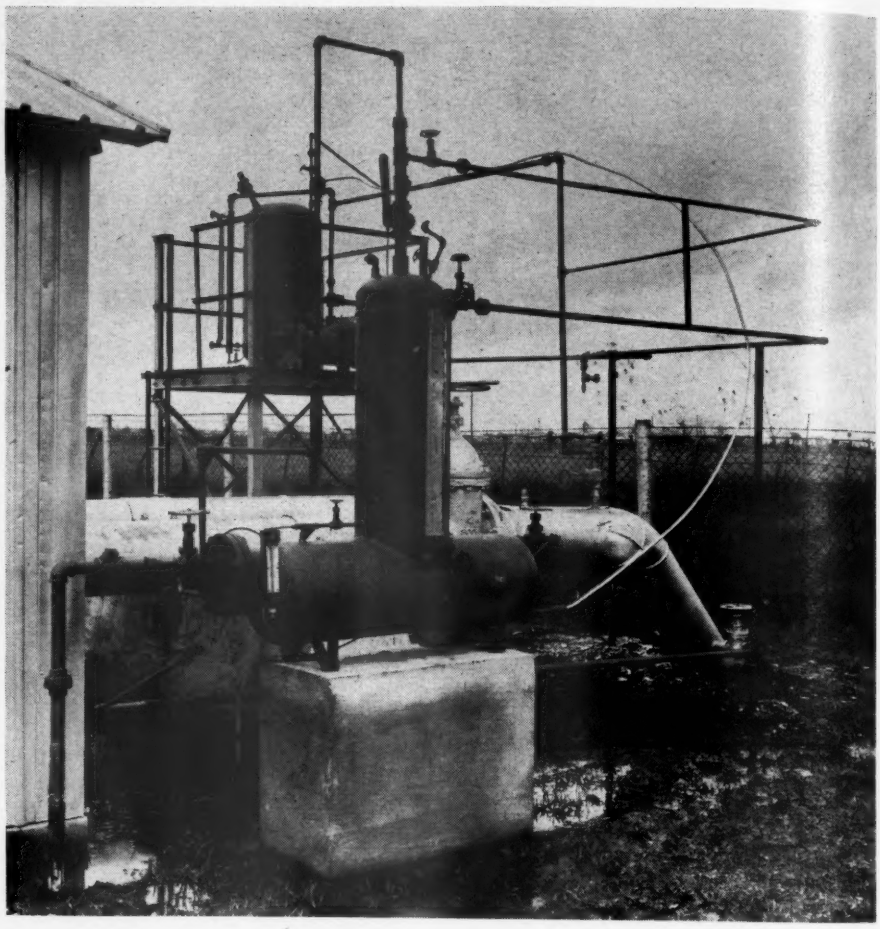
The indicating check valve and drip lip indicators are equipped with glass windows through which the gas flow or dripping liquid can be observed.

The odorizer can also be equipped with a flow indicator by means of which the rate of odorant consumption can be ascertained. The scales can be graduated in pounds per 24 hr and, according to the manufacturer, the accuracy will be within 5 per cent. This attachment is an excellent means of verifying the operation of the equipment.

Pictures of two local installations also accompany this article. In Fig. 1, the indicating check valve and drip lip indicator can be plainly seen and identified by the small circular glasses. The main line connections and the orifice fitting appear in the background.

This odorizer has been in service for over a year and is the one from which the records quoted earlier in this discussion were obtained.

The small line seen at the top right of the picture can be used to transfer to the storage tank any odorant that



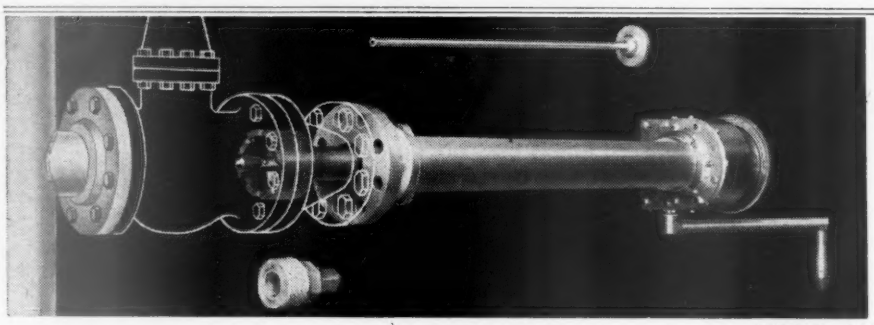


FIG. 2. Drip lip indicator, left center, and flowrater, right.

may accumulate in the horizontal chamber.

Fig. 2 shows the drip lip indicator in the left center with the flowrater just to the right. It can easily be distinguished by the white scales.

The gas deliveries through this station vary from 20,000,000 to 40,000,000 cu ft a day, so an auxiliary storage tank has been installed in order to increase the operating time between fillings. The auxiliary tank is placed on the platform, visible in the rear of the picture. In front of this tank the liquid level control, which keeps the odorizer full at all times, can be seen.

This station was converted from a drip type odorizer to the combination type during October, 1949, and is unusual in that the absorption part of the odorizer is operated by the differential across the meters measuring the gas. The inlet bypass gas line can be seen at the left of the picture just in front of the building. The rate of odorization maintained by this odorizer for the last three months follows:

October, 1949—0.56 lb per million cubic feet; November, 1949—0.51 lb per million cubic feet; December, 1949—0.48 lb per million cubic feet. * * *

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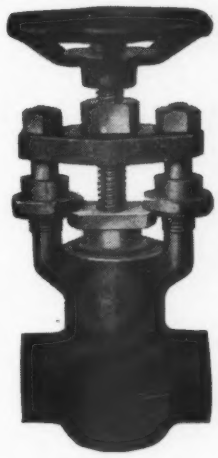

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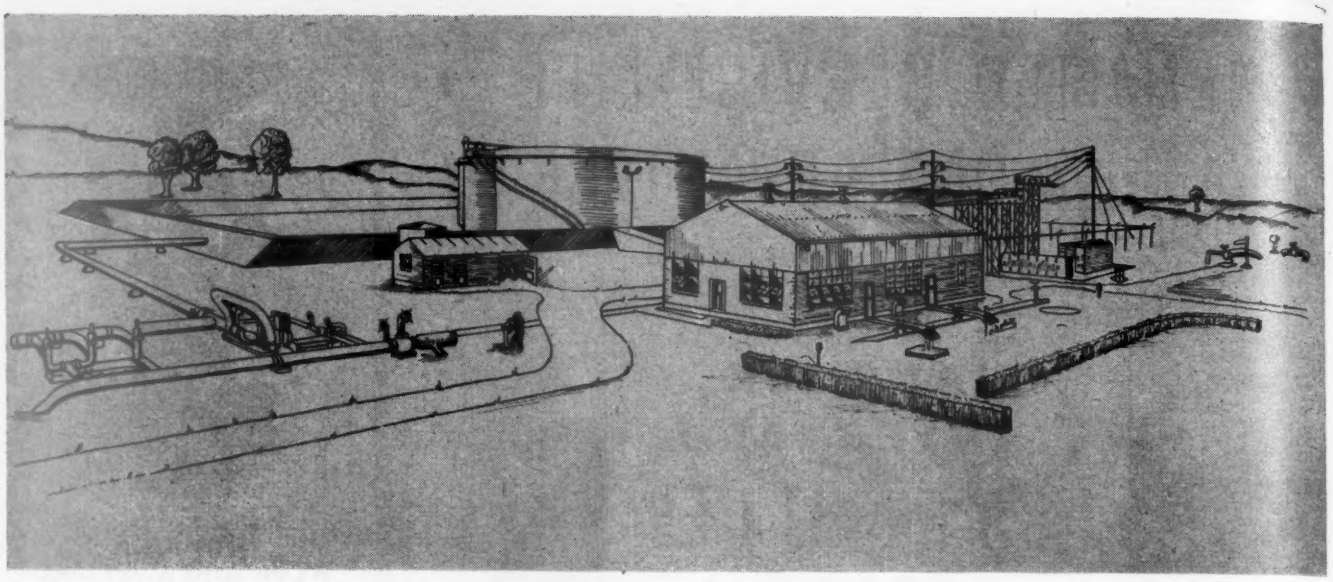


Architect's drawing showing layout of a typical station on Mid-Valley Pipeline Company's system.

Mid-Valley Pipeline System

As a basis for its design, a hydraulic study was made from which a telescoping arrangement was developed and station-spacing determined.

FRANK H. LOVE*

THE construction of the Mid-Valley Pipeline Company's system from Longview, Texas, to Lima, Ohio, is expected to be resumed as soon as weather and ground conditions permit. With most of the major river crossings already completed and the section from Haynesville, Louisiana, to Mayersville, Mississippi, completed, it may be reasonably expected that this important crude oil artery from the Southwest to Ohio will be ready for service some time in the fall of this year.

The Mid-Valley Pipeline Company is owned jointly by the Sun Oil Company and The Standard Oil Company of Ohio. Sun has a refinery at Toledo, Ohio, and Sohio has refineries at Cleveland, Toledo, and Lima, Ohio, and Latonia, Kentucky (near Cincinnati.) Both companies are in the process of completing expansion programs in their refineries in order to keep up with the expanding market in Ohio and nearby areas.

The formation of Mid-Valley Pipeline Company by these two companies for the purpose of building this common carrier line was, therefore, a most logical step. This line will tap the rich oil reserves of the Southwest and will terminate at Lima, Ohio, where deliveries can be made into the recently expanded Buckeye Pipe Line Company's system. This will assure refiners in the Ohio and adjacent areas an economical and reliable artery for crude oil.

Basic Design

After determining the approximate volumes to be handled and the source of supply, detailed studies were made of the investments required for the various line sizes with varying wall thicknesses. Charts were made plotting throughput against total investments, operating costs, and transportation charges that would permit the pipe line to earn 7 per cent net income after taxes. The general trend of these families of curves pointed the way to the selection of the most economical line size for the various sections.

An engineering staff was set up with headquarters in St. Louis, Missouri.

The exact route of the line was a consideration that required an interesting method of approach. A map covering the entire area to be served by the Mid-Valley system was mounted on a table, control points where crude was to be picked up and delivered were then established, and pulleys were mounted on the table at or near these control points. Strings were then run over these pulleys and attached to each other. These strings were weighted on the free end proportionately to the investment cost per mile for the respective sections serving the control points.

*Oil and Gas Pipelining Editor.

EXCLUSIVE

This method developed an approximate route of the line, which aided in the final selection.

The tentative route selected was examined on existing maps and in the field by aerial reconnaissance until a fairly definite route was determined.

Then arrangements were made for an aerial survey. A Sperry-Sun elevation meter was used to profile the areas not appearing on existing contour maps. A profile of the entire line was prepared for purposes of hydraulic study. This was used in studies of telescoping arrangements and station spacing. A thorough investigation developed the following line and station arrangement with corresponding design capacities:

MAIN SYSTEM	Section	Length, mi.	Size, in.	Throughput, bbl/day	Discharge pressure, psi
Longview, Texas	Haynesville, Louisiana	110	20	107,000	1030
Haynesville, Louisiana	Mayersville, Mississippi	127	20	120,000	750
Mayersville, Mississippi (with 3 booster stations)	Hebron, Kentucky	577	22	157,000	935
Hebron, Kentucky	Lima, Ohio	119	20	143,000	1030
SPUR LINES					
Stephens, Arkansas	Magnolia, Arkansas	12	6		
Magnolia, Arkansas	Haynesville, Louisiana	22	8		
Delhi, Louisiana	Mayersville, Mississippi	43	12		
Hebron, Kentucky	Latonia, Kentucky	10	6		

Line Design

A telescoping arrangement was developed for each section using the hydraulic gradient plotted to scale on the profile. Three weights of pipe will be used in a typical section of the 22-in. line as follows:

$\frac{11}{32}$-in. wall.....79.51 lb/ft
$\frac{5}{16}$-in. wall.....72.38 lb/ft
$\frac{9}{32}$-in. wall.....65.24 lb/ft

At the hydraulic center of any one section, the telescoping is begun over again to allow for future booster station construction, which for the 22-in. line will make the ultimate capacity 235,000 bbl per day.

The first design was set up on 42,000-psi minimum yield pipe with a 1.75 safety factor. Later the line was redesigned on the basis of A. O. Smith Corporation's 52,000-psi minimum yield pipe with a 1.75 safety factor and National Tube's API 5LX50 seamless pipe with a wall thickness adjusted to give the same working pressure as the A. O. Smith pipe.

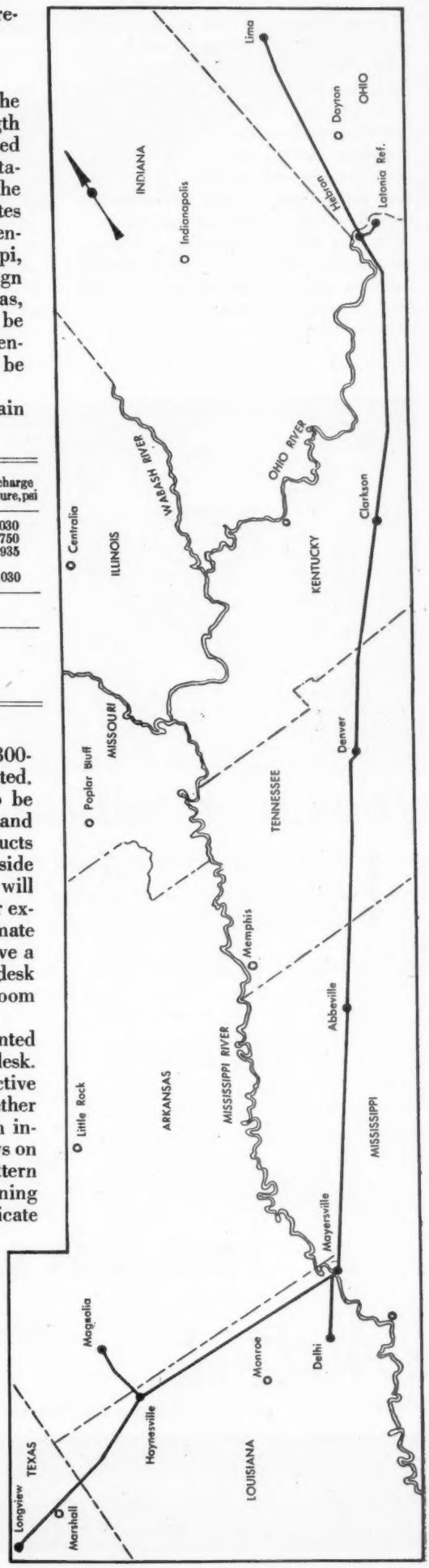
The line will be coated with coal tar enamel and wrapped with either glass or asbestos felt throughout. A major portion of the line will be wrapped with both glass and felt. Permanent electrolysis test stations are being constructed at intervals along the line, two rectifier units are being installed at each pump station location, and additional cathodic protection will be added at a later date wherever required.

Station Design

An economic study was made of the prime movers to determine the length of time necessary to pay out the added investment of a diesel or dual fuel station over an electric station with the savings in power cost. The power rates at Abbeville, Mississippi, Denver, Tennessee, and Mayersville, Mississippi, showed that the electric station design would be desirable. Longview, Texas, and Haynesville, Louisiana, are to be dual fuel, whereas Clarkson, Kentucky, and Hebron, Kentucky, will be straight diesel.

The electric motors for the main line units are to be 3600-rpm, 2300-volt, 1500-hp, and are base ventilated. The motor ventilating fans are to be mounted above the control room and will ventilate the motors through ducts under the floor and discharge outside the station building. Each station will have two units with a provision for expanding to three units for the ultimate design. The control room is to have a raised platform with the control desk facing the pump and motor room through a large window.

The station piping is represented diagrammatically on the control desk. Each valve is shown in its respective position with lights indicating whether the valve is open, closed, or in an intermediate position. Lighted arrows on the control desk indicate the pattern of flow through the station. Warning lamps mounted on the desk indicate any unusual condition such as extreme changes in pipe line pressure or flow, high bearing temperature, low air pressure, etc. The electric units may be started and the station put on the line from the control desk.



Strip map of route of Mid-Valley line from Longview, Texas, to Lima, Ohio.

In the case of the diesel stations, it is necessary to start the engines in the engine room at a control board, after which operation the engine speed may be controlled from the control room. Both stations have emergency shut down controls on the control desk. The pressure controllers, the flow meter, the bearing temperature recorders, and the pressure gages are mounted on either side of the control desk.

In the electric stations, the pressure is controlled through a throttling valve installed on the discharge of the station, which is actuated by a suction and discharge pressure controller.

In the diesel stations, this pressure controller automatically varies the speed of the engines.

The control room also has a tank gage board fitted with remote reading tank gages. Lamps indicate which tanks are being worked. High and low alarms are supplied on all tanks.

The main engines at Longview and Haynesville will be 800-hp atmospheric dual fuel engines, which can be supercharged to 1200 hp when the ultimate capacity is required. At Hebron and Clarkson, 1750-hp turbocharged engines will be installed.

The pumps are 12-in. two-stage centrifugals on the 22-in. section, including Hebron. The 20-in. section between Longview and Mayersville has 12-in. single-stage pumps. These pumps will be exchanged to meet ultimate conditions by replacing with other pumps with the same flange-to-flange dimension.

The electric station buildings are of gable roof design and are to be of concrete block construction to the top of the window level. The remaining parts of the walls and roof are to be corrugated asbestos. The wall height required to install and repair the diesel engines eliminated the gabled roof for the diesel stations in view of the undesirable appearance, therefore, a flat roof design was selected for the diesel stations.

All stations will have a booster pump that can handle the full station stream. In order to keep the stations from having to slow down or throttle because of the different types of crude being pumped by successive stations, it was shown to be economically desirable to install a small capacity booster pump to inject the required make-up to the main line stream. These pumps will pay out with the better efficiencies obtainable from them than would be obtained from the large pumps running at low flows.

The terminals have the following tankage to accommodate the incoming streams:

Location	No. tanks	Capacity, bbl.
Longview	4	81,000
Haynesville	3	81,000
Delhi	3	81,000
Mayersville	11	81,000
Hebron	3	81,000

The booster stations (Abbeville, Denver, and Clarkson) each have one 81,000-bbl tank. This tank is intended to smooth out the flow pattern of the line. All the tanks are equipped with floating roofs.

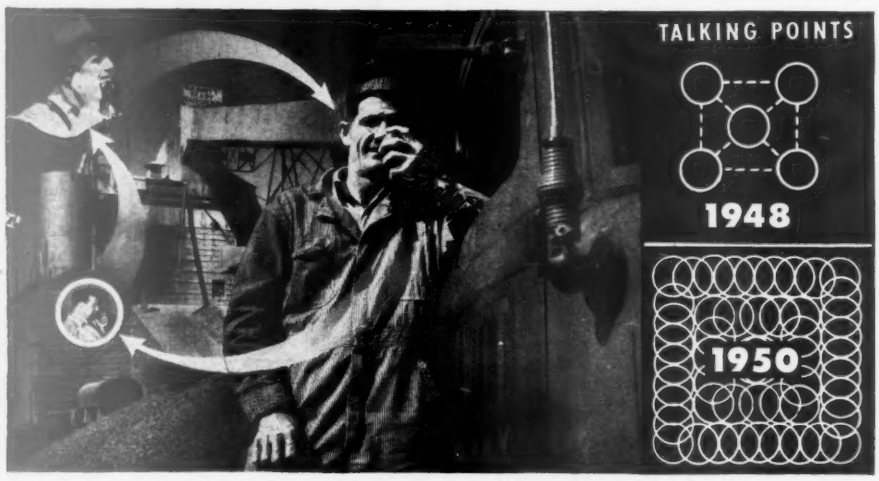
Communication System

Communications will be handled by a microwave system operating in the 6575-6875 mc band.

A total of seven circuits are provided, including a full line teletype circuit, a full line VHF circuit for communications with radio equipped vehicles, and five telephone circuits with dial ringing between points. The telephone circuits are set up to provide for routine line operation as well as private line facilities between division offices and the main office.

When Mid-Valley goes into operation in the late fall, it will represent one of the most modernly designed pipe line systems in the country.

* * *



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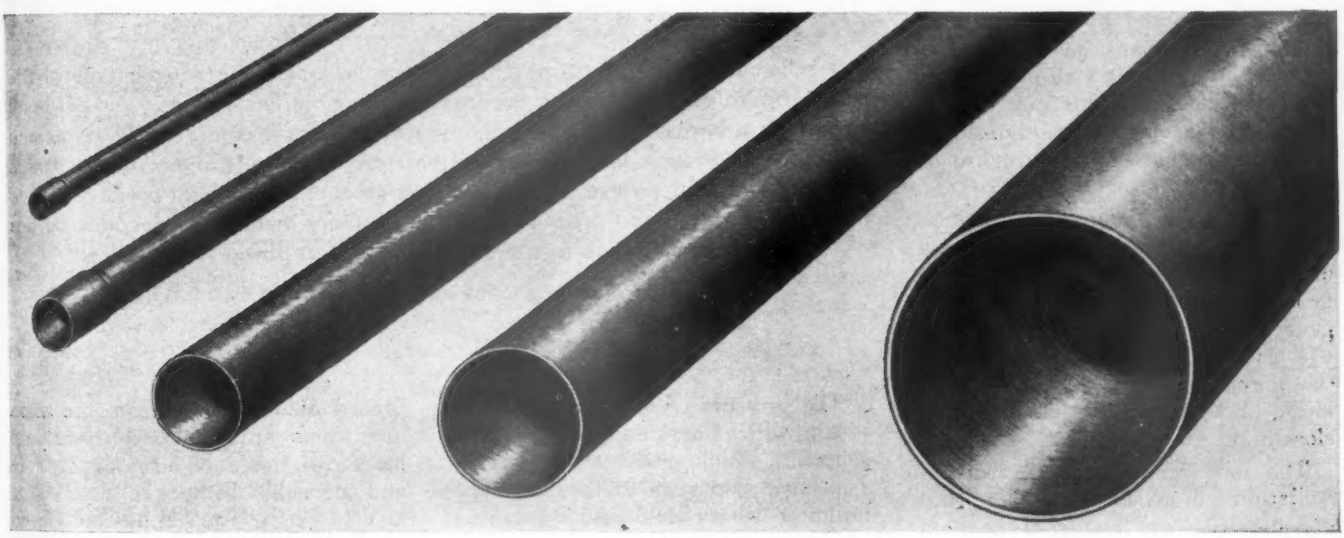
Diameters range from $5\frac{9}{16}$ inches to $12\frac{3}{4}$ inches, in lengths up to 55 feet.

The addition of this new pipe mill now makes it possible for Kaiser Steel to meet practically every transmission pipe requirement of the petroleum, gas and water industries in the western two-thirds of the nation.

It is another illustration of our policy to keep pace with the needs of our customers.



Kaiser Steel pipe to latest API and ASTM specifications—in diameters from ½ inch to 30 inches, and in lengths up to 40 feet—is now available. Shipping points are Fontana and Napa, California.

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KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 22" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	$5\frac{9}{16}$" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	24" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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Remote Control Fire Valves

W. J. QUINLAN*

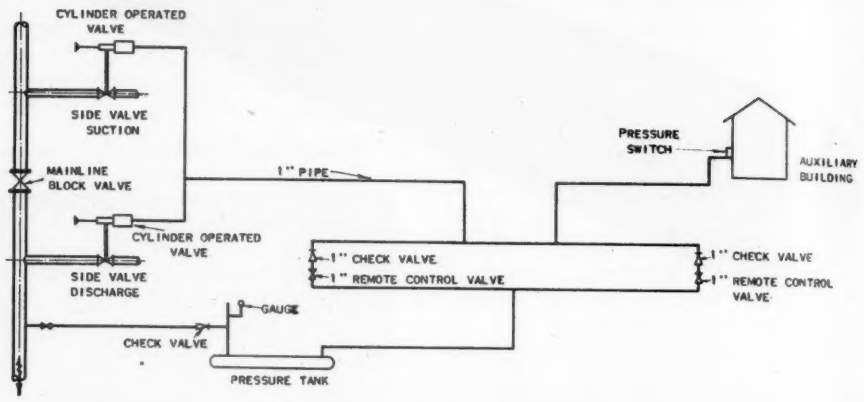
REMOTE control fire valves are being installed at 15 of Northern Natural Gas Company's compressor stations. These stations are at Skellytown, Texas; Beaver, Oklahoma; Sublette, Kansas; Mullinville, Kansas; Bushton, Kansas; Clifton, Kansas; Beatrice, Nebraska; Palmyra, Nebraska; Oakland, Iowa; Ogden, Iowa; Ventura, Iowa; Hooper, Nebraska; South Sioux City, Nebraska; Paullina, Iowa, and Welcome, Minnesota.

The installation of these valves is one of the most extensive safety measures ever adopted by Northern. Although the company has never experienced any serious station disaster, it is expected that this new remote fire control device will minimize any loss in the event of a future fire or explosion.

The present manually operated valves are entirely satisfactory during ordinary operations, but they might be impossible to close during an emergency because of their number, as well as their proximity to a gas fire that may occur in the station. Furthermore, they require too much time to close in the event of a fire.

The new remote fire control installation will make it possible to shut off quickly all gas flow from the main line into the station. All main and loop line side valves to the suction and discharge lines will be fitted with a cylinder mechanism that will be operated from remote control stations.

The remote control system operates with natural gas pressure obtained by tapping the main and loop lines on the discharge side of the plant. This gas is stored under pressure in a suitable reservoir buried in the ground. A 1-in. line carries the gas to the remote control stations. There will be two remote control settings at each of the compressor stations with the exception of Clifton and Sublette, where there will be three. A 1-in. valve at the remote control stations is normally closed. In the event of an emergency it can be quickly opened to allow the gas to flow through 1-in. lines to all of the cylinder operated side valves and simultaneously close them.



This schematic sketch illustrates the manner in which the remote control fire system operates. Starting with the tap into the main line in the lower left-hand corner the progress of the gas is clearly traceable as it enters the reservoir and in turn flows through the 1-in. line to the remote control station. At this station a simple turn of the valve activates the system and allows high pressure gas to flow to side valves and pressure switch in auxiliary building. In seconds all gas flow from main line to station is shut off and power is suspended.

The pressure of the gas actuates a piston, which operates a rack and gear segment, which closes the valve. A 1-in. line also runs to the auxiliary building where a pressure-operated switch grounds out the compressor and generator engines and shuts off all the power in the station. Similarly, solenoid operated valves shut off all appliances to extinguish any open flames. When operation of the station can be resumed, all valves and switches must be opened manually.

The highest discharge pressure reached at the station will be maintained in the reservoir as a check valve allows the gas to flow in only. In the event the filling line to the reservoir is broken the system will still operate, as the reservoir contains an ample quantity of high pressure gas to do the work required.

A vent valve is kept open at each remote control station so that in the event of leakage at the control valve, pressure will not seep into the line to the side valves and auxiliary building and operate the system. This vent valve closes when the control valve is opened.

The remote control settings are placed about 500 ft from the main operations area, as past experience has shown this to be a reasonably safe and accessible distance in the event of an emergency. The settings are placed at diverse ends of the station so that if one of them is not accessible the other will be. Twelve miles of 1-in. pipe will be required for the various units. The systems are all scheduled to be in operation by fall. The company plans a series of fire drills to acquaint the employes with their duties during an emergency, as well as the general mechanics of the system.

Preventing gas under high pressure from entering the station during an emergency will greatly reduce the attendant damage of explosion or fire and minimize the total damage.

The remote fire control systems are being installed at a cost of approximately one quarter million dollars. Although this is a considerable sum, the additional outlay of money is well justified by the increased protection it will afford Northern employes, Northern's service to its customers, as well as Northern's compressor station property. ***

*Northern Natural Gas Company.

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Worthington Achieves a Triumph in Modern Angle Gas Engine Compressor Design with the Uniflo TYPE UTC-16's...Thru-Scavenging, 2-Cycle Engines of 800—2,000 HP that Hit New Highs in Efficiency AND Economy...Outstanding on Pipeline Duty

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AIR PORTS AROUND ENTIRE CIRCUMFERENCE OF CYLINDER. Port area more than double.

EXHAUST THRU CAM OPERATED TIMED VALVES IN CYLINDER HEAD. Area 50% greater.

STRAIGHT LINE AIR FLOW thoroughly cleanses and cools entire cylinder.

SUPERCHARGING. Timed valves retain greater weight of pure air for perfect combustion.

THESE IMPROVEMENTS result in higher mean effective pressures without increased temperatures.

2. EN BLOC FRAME — permits use of removable cylinder liners.

3. DOUBLE AIR MANIFOLDS — doubles volume of air and steadiness of flow.

4. RENEWABLE CYLINDER LINERS — mean longer life and low-cost maintenance.

5. PISTON — completely symmetrical outer piston wall — wrist-pin supported in separate carrier.

6. CYLINDER HEAD — Worthington cone-type ... two large exhaust valves — streamlined passages.

7. GEAR DRIVEN CAMSHAFT — assures positive drive and perfect timing.

8. IMPROVED COOLING — jacket water space cast integral with liners, eliminating internal water seals.

9. LUBRICATING SYSTEM — Worthington cast-in manifolds, positive pressure lubrication to every running part.

10. ACCESSIBILITY — inherent in straight-line engine design, increased by large access doors on both sides of the engine frame.

11. WORTHINGTON FEATHER* VALVES: lightest, tightest, quietest ever made used in both compressor and scavenging cylinders.

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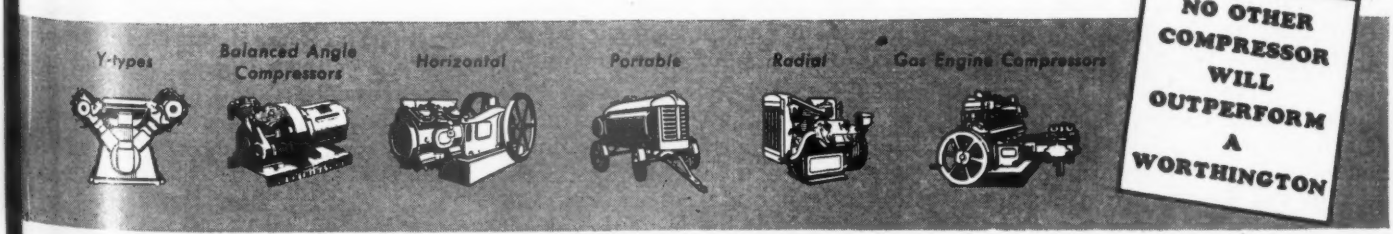
In addition to Worthington's experience covering half a century of building compressors for pipeline duty, more than seven years of intensive research devoted to developing the uniflo scavenging principles have gone into producing the TYPE UTC-16. The result is an Angle Gas Engine Compressor that meets the rigid requirements of gas pipeline service with more efficient use of fuel, cooler operation, improved accessibility and longer service life. For further facts about the uniflo TYPE UTC-16 — and proof that here, again, *there's more worth in WORTHINGTON* — contact your nearest Worthington Branch Office or the *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

*Reg. U. S. Pat. Off. EK.0.1



NEWS

Cooper-Bessemer Given Mid-Valley Contract

A one-half million dollar contract has been awarded The Cooper-Bessemer Corporation, Mt. Vernon, Ohio, by the Mid-Valley Pipeline Company. The contract covers gas-diesel engines for driving oil pumps on Mid-Valley's 22-in., 1000-mile oil pipe line from Longview, Texas, to Lima, Ohio.

Operating on a dual-fuel principle, these engines run on a mixture of natural gas and crude oil. In event of restriction in natural gas supplies, as possible during critical winter months, the Cooper-Bessemer gas diesels scheduled for the Mid-Valley line will be able to continue running on crude oil alone. Natural gas for operation will be drawn from nearby gas transmission lines of the Texas Gas Transmission Corporation and the Tennessee Gas Transmission Company. Oil for fuel will be bled directly from the Mid-Valley line.

Scheduled for delivery in May, the gas-diesel engines totaling more than 10,000 hp are to be installed in four of the seven pumping stations this summer. The first station at Longview, Texas, alone will have sufficient capacity to fill the 1000 mile 22-in. pipe line with crude oil and pump the oil to Lima, Ohio, at a rate of 50,000 bbl a day. When other stations are cut into the line, this daily output will be progressively increased until an anticipated 200,000 bbl a day is reached for delivery to Sun Oil Company and Sohio refineries in Ohio.

Pan American Completes Scurry Gathering System

Pan American Pipe Line Company recently completed a gathering system in Scurry County, Texas, consisting of 24 miles of 6-in. and 7 miles of 4-in., from the Kelly and North Snyder fields to the Colorado City station of the Basin Pipe Line System. The contractor was Golightly Construction Company. A field station has been installed in the Snyder field. Pumping equipment includes a duplex gathering pump and two centrifugal pumps to boost the oil to the Basin station.

Hearing Set for June 19 On Canadian Gas Line

Western Pipelines has applied to the Canadian Petroleum and Natural Gas Conservation Board for permission to build a pipe line and export gas from the Province of Alberta. The line would be laid eastward by way of Regina and Winnipeg. Hearing on the application is scheduled for June 19.

Natural Gas Transmission Facilities To Cost $195,587,700

Natural gas transmission facilities designed to add more than one billion cubic feet of daily delivery capacity to the nation's individual pipe line systems were authorized by the Federal Power Commission during the six-month period ending December 31, 1949, it was announced by Chairman Nelson Lee Smith.

The authorized facilities involve 2637 miles of pipe line and have an estimated total construction cost of $195,587,697.

Approximately $186,278,900 of the total construction cost was for major projects estimated to cost $700,000 or more. The major projects are expected to benefit 68 cities of 50,000 population or more in 19 states and the District of Columbia as well as numerous smaller communities.

These larger projects will increase capacities of the individual pipe line systems involved by at least 1,057,500,000 cu ft of natural gas per day, and involve construction of approximately 2460 miles of new pipe lines and installation of compressor facilities aggregating 124,625 hp.

Largest single authorization during the six-month period was for Tennessee Gas Transmission Company to construct a main transmission line from Kentucky to Buffalo, New York, and additional loop lines and compressor units on its main Texas-to-Kentucky line. This project involves 1032 miles of pipe line and 73,000 hp in additional compressor units, and is estimated to cost $76,116,585. The facilities are designed to deliver 169,000,000 cu ft of gas per day to new markets along the route of the Kentucky-Buffalo extension and to meet increasing requirements of Tennessee's present customers on its existing system.

These facilities were the remaining part of Tennessee's larger over-all project which involved 1703 miles of pipe line and 104,400 hp in compressor units. The complete project, estimated to cost $138,975,804, will deliver 340,000,000 cu ft of natural gas per day. The other facilities were authorized in December, 1948, and May, 1949.

During the calendar year ending December 31, 1949, the Commission authorized construction of a total of 7571 miles of pipe line and installation of compressor units aggregating 499,800 hp at a total estimated cost of $615,249,100. The major projects costing $700,000 or more authorized during the calendar year involved a total estimated construction cost of $538,002,400 and included 7100 miles of pipe line and installation of 488,000 hp in compressor units.

Since February 7, 1942 (the date when the present certificate provisions of the Natural Gas Act became effective), the Commission has authorized a total of more than 30,100 miles of pipe line and 1,904,000 hp in compressor units at a total estimated cost of $1,824,099,000.

FPC Issues Its Twenty-ninth Annual Report

The Federal Power Commission has announced the issuance of its 29th annual report covering the fiscal year ended June 30, 1949.

The report, which presents for Congress and the public a background on Commission activities during the fiscal period, reviews FPC functions in connection with natural gas, electric power, rate regulation, corporate regulation, licensing of hydroelectric projects, accounting, river basin surveys, and power requirement studies.

The period is described in the report as one in which FPC activities "took on added scope and significance as the natural-gas and electric-power industries maintained their vigorous growth" while the Nation's economic activity in general showed the first signs of leveling off from the postwar upsurge.

Natural gas pipe line construction programs authorized by FPC during the year were estimated to cost $566,203,000, the highest of any year since the passage of the Natural Gas Act, the report says. Ninety-one certificates of public convenience and necessity were issued during the period, and they involved 7045 miles of pipe line and 436,274 compressor horsepower. This compared with 98 certificates with a total estimated cost of $520,000,000 issued in fiscal 1948.

Copies of the report may be obtained from the Publications Section, Federal Power Commission, Washington 25, D. C., at 35 cents each. The order number is FPC-A-37.

Stanolind Begins Laying West Texas Pipe Line

Stanolind Pipe Line Company has begun construction of a 36-mile 8-in crude oil line from its Post pumping station in Garza County, Texas, to the new Cogdell field in southern Kent County. From the Post station crude oil will be pumped to the Monroe station, a distance of 85 miles, where it will enter the company's trunk system. The capacity of the new line will be 10,000 bbl a day.

I.C.C. Figures Show Postwar Expansion in Pipe Lines

The accompanying table shows for the years 1941-1949 the transportation revenue and the number of barrels of oil originated on line and received from connections as reported by large oil pipe line companies subject to the jurisdiction of the Interstate Commerce Commission. Transportation revenue of these lines increased 0.2 per cent in 1949 over 1948 but traffic volume declined 9.4 per cent. In comparison with the returns for 1941 (essentially a prewar year) the carriers' 1949 revenues were up 47.2 per cent and traffic volume increased 55.8 per cent. The marked postwar expansion in oil pipe line operations is indicated by the fact that in 1947, 1948, and 1949 the volume of traffic and the revenues exceeded those of the peak war year 1944. These increases over 1944 occurred in the face of the general resumption of tanker service, which was greatly restricted during the war. In some part also the postwar increases presumably reflect a return to the pipe lines of some oil traffic carried by the rails under the wartime pressures for transport. However, there has been considerable postwar expansion of the pipe line network. Oil pipe line companies subject to the jurisdiction of the ICC reported a total of 111,615 miles of line operated (both trunk and gathering) at the close of the year 1944 as compared with 124,092 miles on December 31, 1948, or an increase of 11.2 per cent.

Year	Transportation Revenue[1]	Number of barrels of oil originated on line and received from connections[1] thousands
1941	$233,085,128	1,488,838
1942	227,967,538	1,619.579
1943	261,571,709	1,949,685
1944	290,293,589	2,235,400
1945	279,982,686	2,174,677
1946	273,326,620	2,107,417
1947	300,092,514	2,317,256
1948	342,534,525	2,559,912
1949	343,204,467	2,319,163
Per cent increase: 1949 over 1941	47.2	55.8

[1]Based on quarterly reports of oil pipe lines having revenues of more than $500,000 per annum.

The results of the operations of the "Big Inch" and "Little Inch" government financed pipe lines during the war years are not included in the above figures as they did not report to this Commission; however, the larger proportion of oil transported by the "Big Inch" line was originated by carriers reporting to the ICC. All oil transported by the "Little Inch" was originated on its own line.

Pipe Line Movement Refined Products Increases

Refined products transported by pipe lines increased 11.8 per cent in 1949 as compared with 1948, a recent report issued by the U. S. Bureau of Mines reveals. Products delivered from lines totaled 344,984,000 bbl, an increase of 36,422,000 bbl over 1948. At the same time, products turned into lines amounted to 346,694,000 bbl in 1949, up 33,742,000 or 10.7 per cent from the preceding year.

A total of 31,873,000 bbl were delivered from lines in December, an increase of 4,374,000 or 15.9 per cent from the year-earlier month. The report also stated that 31,996,000 bbl were turned into lines in the month, up 3,955,000 or 14.1 per cent from December, 1948.

Of the total volume of products delivered from lines in 1949, 82 per cent was motor fuel, 14 per cent distillate fuel oil, and 4 per cent was kerosine. Ratios in the preceding year were 79 per cent motor fuel, 15 per cent distillates, and 6 per cent kerosine.

Motor fuel accounted for 80 per cent of the volume of products turned into lines in the year, with distillates responsible for 14 per cent, and kerosine for 6 per cent. In 1948, 78 per cent of the volume was motor fuel, 15 per cent was distillate fuel, and 7 per cent was kerosine.

A total of 278,221,000 bbl of motor fuel were delivered from lines in 1949, an increase of 35,070,000 or 14.4 per cent from 1948. December deliveries amounted to 22,856,000 an increase of 2,870,000 or 14.4 per cent from the year-earlier month.

Increases in heating oil deliveries were accounted for almost entirely by sharply increased business in December.

Deliveries of distillate fuel oil totaled 49,097,000 bbl in the year, up 2,341,000 or 2.8 per cent. December deliveries at 6,617,000 were up 1,208,000 or 22.3 per cent.

Kerosine deliveries in the year were 17,666,000 bbl, an increase of 11,000 or less than 1 per cent. December deliveries, however, totaled 2,400,000 bbl, an increase of 296,000 or 14.1 per cent from December, 1948.

Motor fuel turned into lines in the year amounted to 279,645,000 bbl, up 33,392,000 or 13.6 per cent from the 1948 volume. In December, a total of 22,756,000 bbl were turned into lines for an increase of 1,707,000 or 8.1 per cent.

Distillates turned into lines in 1949 totaled 49,181,000 bbl, an increase of 1,562,000 or 1.2 per cent from the preceding year. December volume at 6,858,000 bbl was up 1,821,000 or 36.2 per cent from the year-earlier month.

Kerosine turned into lines in the period totaled 17,868,000 bbl and was the only product to show a decline, falling 212,000 bbl or 1.2 per cent below 1948. In December, 2,382,000 bbl of kerosine was turned into lines, an increase of 427,000 bbl or 21.8 per cent from the year-earlier month.

The ratio of motor fuel turned into lines to total motor fuel production was 29 per cent in 1949 as compared with 26.7 per cent in 1948. Ratios for the two Decembers were approximately the same at 25.1 per cent.

East Tennessee Natural's Financing Plan Approved

The Federal Power Commission has approved East Tennessee Natural Gas Company's proposed plan of financing its Lobelville-Chattanooga-Knoxville pipe line, authorized by FPC on January 30, 1948. The 1948 authorization was conditioned to require East Tennessee to submit for commission approval its financing plan.

East Tennessee's plan of financing, filed January 18, 1950, and later modified and supplemented, will provide funds required for a tie-line in the Knoxville area, authorized November 15, 1949, as well as for the Lobelville-Chattanooga-Knoxville line.

Total cost of these facilities is estimated at $11,765,900. The company proposes to raise the funds through the issuance and sale of (1) $6,750,000 in first mortgage pipe line bonds, 3½ per cent series, due May 1, 1969; and (2) $4,800,000 in 5.2 per cent interim notes, Series C, due April 1, 1951, and 115,200 shares of $1 par common stock. Any required balance will be obtained through cash derived from company operations of its completed facilities.

East Tennessee plans to sell the $6,750,000 in first mortgage bonds at 100 per cent of the principal amount plus accrued interest to the date of delivery to the following institutional purchasers: Metropolitan Life Insurance Company, Mutual Life Insurance Company of New York, and New York Life Insurance Company.

The interim notes and common stock are to be offered in 192,000 units, each consisting of a 5.2 per cent interim note and six-tenths of one share of common stock. The proposed price is $26.25 from which East Tennessee will realize $25 plus accrued interest. Underwriters will be the Weld, F. S. Moseley, Equitable Securities, and Elder companies.

TRANSPORTATION PERSONALS

A. P. Kramer

A. P. Kramer has been advanced from assistant to the general superintendent to general superintendent of Great Lakes Pipe Line Company.

The new superintendent takes over part of the responsibilities of **J. B. Lawson,** a vice president of the pipe line company, who until appointment of Kramer had also been general superintendent.

Prior to being named assistant to the general superintendent, Kramer was supervisor of pumping stations for the northern area, which encompasses lines of the company between Kansas City and Minneapolis and from Des Moines to Chicago.

Great Lakes operates as a common carrier, transporting refined petroleum products from Oklahoma and Kansas refineries to 14 company-owned delivery terminals. Its lines traverse nine midwestern and north-central states.

The company is now engaged in a $55,000,000 expansion program that will virtually double capacity of its system.

J. E. Bercher, assistant manager of the pipe line department of Deep Rock Oil Corporation, addressed the March meeting of The Pipe Liners Club of Tulsa on the subject "Crude Oil Transportation Problems in the Lower Mississippi River Area." The paper treated problems of overland transportation facilities necessary to reach the watercourses from production sources, as well as transportation problems by barge and tanker along the watercourses.

Bill Wilkins, for many years in Tulsa, Oklahoma, with the pipe line division of Gulf as chief engineer but now making his headquarters in Pittsburgh, was a recent visitor to the Mid-Continent area.

S. G. Dale has been appointed chief station engineer at Freeman, Missouri, by the Stanolind Pipe Line Company.

Graydon A. Scrafford has been appointed general manager of The Buckeye Pipe Line Company with offices at Lima, Ohio.

R. V. Herman, equipment engineer, and **R. L. Carruthers,** area training representative, Shell Pipe Line Corporation, are new members of The Pipe Liners Club of Tulsa. Others recently admitted to membership are: **Jack W. Foster, Jr.,** supervisor of line maintenance and construction equipment, Stanolind Pipe Line Company; **Walter A. Geppelt,** president, Southwest Piping and Fabricating Company; **F. E. Hart,** division superintendent, Gulf Refining Corporation, and **Robert Nee,** district sales representative, Koppers Company, Inc.

Supervisory transfers announced by Shell Pipe Line Corporation are as follows:

P. M. Crenshaw to acting division superintendent, Wasson-Hobbs.

J. G. Robison to gauging inspector, Mid-Continent.

R. J. Evans to assistant gauging inspector, West Texas.

J. E. Fairweather to district foreman, Benedum.

T. V. Brownlee to district foreman, TXL-Wheeler.

L. H. Gibson to station chief engineer, Fredericksburg.

L. L. Arnold to station chief engineer, LaGrange.

C. E. Branson to station chief engineer, Big Lake.

W. K. Williams to station chief engineer, Hamlin.

P. D. Funderburk to station chief engineer, Monahans.

W. T. Porter to district gauger, Goldsmith.

L. L. Gentry to district gauger, Hobbs.

M. D. Pool to district gauger, Monument.

Sam Bean, superintendent of the Wasson-Hobbs division of Shell Pipe Line Corporation, is now in Venezuela to assist Shell Caribbean Petroleum, an affiliate, in construction of the "Steep Inch" line. The project gets its name from the fact that the route of the line is from sea level to an altitude of 3200 ft in a distance of approximately 10 miles. Bean is making his residence near Caracas at the seaport town of La Guaira. **P. M. Crenshaw** is acting division superintendent during his absence.

Earl Millroy, former superintendent for Loudon Pipeline Company, St. Elmo, Louisiana, recently joined Johnson Oil Supply Company, Gary, Indiana. He will serve as refinery superintendent for Johnson Oil Supply.

Tennessee Gas To Increase Capital Stock

Stockholders of the Tennessee Gas Transmission Company have voted a more liberal retirement benefit program for company employees and authorized an increase in the company's capital stock.

The amended retirement plan becomes effective July 1. The scheduled retirement pay upon reaching retirement age of 65 was increased an average of 40 per cent for the approximately 1300 employees qualified under the plan. The increased cost of the revised plan will be borne entirely by the company, according to Gardiner Symonds, president.

The increase in authorized capital stock permits the issuance of a total of 600,000 shares of $100 par value preferred stock and 10,000,000 shares of $5 par value common stock. The company had been limited previously to 400,000 shares of preferred stock and 5,000,000 shares of common stock.

The additional stock authorized may be issued in the future but there are no immediate plans for the sale of the additionally authorized stock, Symonds said. However, the company does plan next month to sell 100,000 shares of preferred stock previously authorized, plus an undetermined amount of bonds later in the summer, to partially care for the current construction program, Symonds explained.

All company directors were re-elected at the annual meeting. They are: Ardon B. Judd, A. Dee Simpson, W. E. Mueller, and Symonds, all of Houston; R. K. Hanger of Fort Worth, Eugene McElvaney of Dallas, and Roy S. Nelson of Beaumont.

At a director's meeting following the stockholders meeting, the following officers were re-elected: Symonds, president; C. S. Coates, C. A. Lingo, W. C. Norman, R. G. Rice, and Mueller, vice-presidents; Carl Myers, treasurer and W. D. Walser, secretary. All are of Houston.

With the PIPE LINE CONTRACTORS

Midwestern Constructors, Inc., 105 North Boulder Street, Tusla, Oklahoma, has contracted to lay two sections of line for the Northern Natural Gas Company, which work is scheduled to begin in June. Section 6 consists of 43.4 miles of 26-in. between Palmyra, Nebraska, and Oakland, Iowa. Section 7 consists of 65.9 miles of 26-in. northeast from Oakland.

Midwestern did the engineering work on a gathering system for Plains Natural Gas Company. Project A, 80 miles of 4 and 24-in., has been completed, and the remaining 120 miles got under way March 15. The field office is at Liberal, Kansas, and Lyle S. DeWitt is the chief inspector.

Dumas Pipe Coating Company, P.O. Box 1351, Wichita Falls, Texas, is coating 118 miles of pipe varying in size from 3 to 22 in., for Vaughn and Taylor Construction Company, Inc. The pipe is being installed by the latter for Phillips Petroleum Company as a gas gathering system in Sherman and Hansford Counties, Texas. The work began March 4.

Houston Contracting Company, 3272 Westheimer Road, Houston 19, Texas, is now engaged in laying 105 miles of 22-in. crude oil line for Mid-Valley Pipeline Company from Oakland, Mississippi, to Henderson, Tennessee. Headquarters are at Batesville, Mississippi. E. C. Norris is superintendent, R. E. Thornton assistant superintendent, and R. J. Axsom office manager.

Vaughn and Taylor Construction Company, Inc., Hamilton Building, Wichita Falls, Texas, began work in March on 118 miles of gas gathering lines, varying in diameter from 3 to 22 in., for Phillips Petroleum Company. The gathering system is being installed in Sherman and Hansford Counties, Texas. The field office is at Texoma, Oklahoma. D. D. Vaughn is in charge of the spread and C. E. Sayles is office man.

H. C. Price Company, Box 1111, Bartlesville, Oklahoma, has several spreads at work for the Tennessee Gas Transmission Company, as follows:

Sixty-three miles of 26-in. from the south bank of the Mahoning River, near Youngstown, Ohio, extending southwestward. Work began April 10. Headquarters are Columbiana, Ohio, with G. A. Reutzel superintendent.

From the north bank of the Muskingum River extending northeastward, 63 miles of 26-in. Headquarters are at Zanesville, Ohio, with R. K. Shivel superintendent.

From the south bank of the Muskingum River extending southwestward, 47 miles of 26-in. This job also began April 1. Field headquarters are at McConnelsville, Ohio. W. B. Williams is superintendent.

From the north bank of the Ohio River extending northeastward, 47 miles of 26-in. The spread is making its headquarters at Portsmouth, Ohio, with C. R. Ice the superintendent. Work got under way April 1.

In August work will begin on 373 miles more of 26-in. for Tennessee. This section will extend from the north bank of the Ohio River to a point near Buffalo, New York.

N. A. Saigh Company, Suite 531 Majestic Building, San Antonio, Texas, will open a warehouse and office at Athens and Cleveland, Tennessee, on April 20 for work on 150 miles of 12-in. for East Tennessee Natural Gas Company. The line will be laid from Athens to Tullahoma by way of Chattanooga. Later a warehouse and office will be opened at Chattanooga. Carl Doyle will be general superintendent, James E. Gray manager of field offices, and Robert E. Floyd foreman of Spread No. 1.

Brodie Construction Company, Box 2064, Amarillo, Texas, began work March 1 on 37 miles of 12-in. for the Great Lakes Pipe Line Company from a point north of Pattonsburg, Missouri, to a point across the Iowa line. The field office is at Bethany, Missouri, with A. T. Rathjen the superintendent and S. A. Newton welder foreman.

Wunderlich and Griffis Pipe Construction Company, 745 Riverside Drive, Tulsa, Oklahoma, is laying spreads Nos. 13 and 14 on the Transcontinental Gas Pipe Line Corporation system. Spread No. 13 is from the Susquehanna River to the Delaware River, totaling 84 miles. Spread No. 14 extends from the Delaware River to the Hackensack River in New Jersey, a distance of 41 miles.

Bechtel-Price-Conyes, 220 Bush Street, San Francisco, California, is working in the vicinity of Ludlow, California, on the Pacific Gas and Electric Company 34-in. line that will extend from Topock, Arizona, to Milpitas, California. A double-ending plant is in operation at Barstow. R. L. Bowman is general superintendent and M. V. Scott manager of the mainline office, P. O. Box 698, Barstow, California. Steve Valline is manager of the project office, San Francisco.

A. C. Holder Construction Company, 2615 East Admiral Place, Tulsa, Oklahoma, is laying 72.33 miles of 12-in. for the Great Lakes Pipe Line Company as one section of a parallel line the company is installing between Minneapolis, Minnesota, and Des Moines, Iowa.

H. L. Gentry Construction Company, 921 Michigan Avenue, Jackson, Michigan, is now at work on its section of line for Mid-Valley Pipeline Company. Between Mt. Washington and Hebron, Kentucky, 90 miles of 22-in. pipe will be laid.

Trojan Construction Company, Inc., P. O. Box 4427, Oklahoma City, Oklahoma, wound up early in April approximately 72 miles of 12-in. for the Great Lakes Pipe Line Company. This section extends from North Kansas City, Missouri, northward through Platte, Clay, Clinton, DeKalb, and Daviess Counties. The work was done by two spreads. Swede Tillotson was superintendent in charge of the spread working out of North Kansas City office, where Vernon Yeager was office manager. Felix M. Johnson was superintendent of the spread working out of Cameron, Missouri. John Miller was office manager. Work is progressing on 48 miles of 8-in. from Tulsa to Cushing, Oklahoma. The field office was at Sapulpa with Al Johnson superintendent and Walter Wells office manager.

Fish Constructors, Inc., M. and M. Building, Houston, Texas, is acting as agents for construction of the Transcontinental Gas Pipe Line Corporation system from the Lower Rio Grande Valley to New York City. The line will be completed this year. Work is now going forward on the section between Athens, Georgia, and New York. The Fish organization is building the compressor stations.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, is laying 86 miles of 26-in. for Transcontinental Gas Pipe Line Corporation, the section extending from Danielsville, Georgia, to the Saluda River in South Carolina. Work will begin in May on the section of line the company will lay between Regina and Gretna for Interprovincial Pipe Line Company. A crossing of the Mississippi River is being installed at South St. Paul for the Great Lakes Pipe Line Company.

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, expects to start May 1 on the Salt Lake Pipe Line Company 8-in. between Burley and Boise, Idaho, a distance of 163 miles. Resumption of this work has been awaiting favorable weather conditions. Aldress Kilgore will be in charge with the field office at Mountain Home. The date now set for the beginning of work on the Portland Pipe Line Corporation project, 85 miles of 16-in., is June 1. Laying of Transcontinental Gas Pipe Line Corporation's line in New Jersey, between the Hudson and Hackensack Rivers, continues to progress. M. E. Shiflett is superintendent and the field office is at Edgewater.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors), have the following jobs under way or contracted:

For H. C. Price Company (Tennessee Gas Transmission Company line), 400 miles of 26-in. in Ohio, Pennsylvania, and New York. For the same companies 177 miles of 30-in. in Kentucky and Tennessee.

For Eastern Construction Company (Mid-Valley system), 75 miles 22-in.

For Oklahoma Contracting Corporation (Salt Lake Pipe Line Company system), 60 miles 8-in. in Idaho.

For Conyes Construction Company (Montana-Dakota Utilities Company line), 340 miles of 12-in. in Wyoming and Montana.

For El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

For Britton Construction Company (Tennessee Gas Transmission Company line), 35 miles of 16-in. in Pennsylvania.

Morrison Knudsen Company, Inc., Macco Corporation, and **Bechtel Corporation** will begin work as soon as weather permits on 140 miles of 8-in. refined products line between Boise, Idaho, and Baker, Oregon, for Salt Lake Pipeline Co.

Morrison Construction Company, P.O. Box 798, Austin, Texas, expects to complete in May the 178 miles of 18-in. crude oil it is laying for Humble Pipe Line Company from Kemper, Texas, to a point between Fredericksburg and Llano. This is a part of Humble's new system from West Texas to the Gulf Coast area.

Britton Construction Company, P.O. Box 344, Russellville, Kentucky, began work April 1 on 111 miles of 22-in. for Mid-Valley Pipeline Company. The section is from Russellville to Elizabethtown, Kentucky. A field office has been opened at Russellville with H. R. Britton manager, Fred N. Peters spread superintendent, E. Howard Smith, Jr., office manager, and Ed Simmons welding foreman.

Mahoney Contracting Company, Hersee Building, Mt. Pleasant, Michigan, is laying 50 miles of 4 through 10-in. lateral gas lines for the National Utilities Corporation to serve Coldwater, Benton Harbor, South Haven, Grand Haven, and Allegan, Michigan. Henry Mogg is superintendent. Work began March 25 on 120 miles of 20-in. for Mid-Valley Pipeline Company between the Ohio River and Lima, Ohio. Field offices have been established at Hamilton and Covington, Ohio. Harold Finnerty is superintendent.

O. R. Burden Construction Corporation, 6702 East Twenty-first Street, Tulsa, Oklahoma, began work during March on 120 miles of 20-in. line for Mid-Valley Pipeline Company, between Longview, Texas, and Haynesville, Louisiana. The contractor got under way the early part of April on 42.5 miles of 16-in. for the Texas-Empire Pipe Line Company. The line is from the Wilmington, Illinois, pumping station to South Gary, Indiana.

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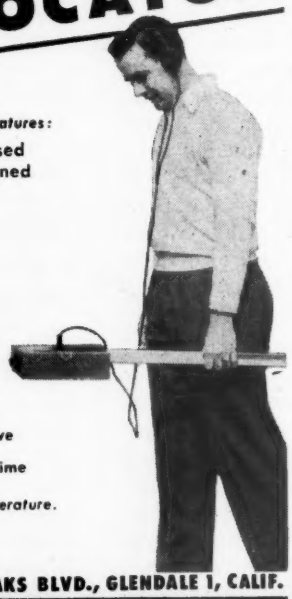

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Eastern Construction Company, 1801 Mercantile Bank Building, Dallas, Texas, is now making ditch on the Mid-Valley Pipeline Company job, having completed the right-of-way and installed river crossings. The section consists of 155 miles of 22-in. between Hornsby, Tennessee, and Russellville, Kentucky. Fred Byers is general superintendent. The main field office is at Waverly where J. W. Arthur is office manager. Two spread offices have been opened, one at Clarksville where L. A. Stewart is spread foreman and J. D. Jones office manager, the other at Lexington where Cliff Simmons is spread foreman; Fred Harwell office manager.

Smith Contracting Corporation, 1410 Fort Worth National Bank Building, Fort Worth, Texas, is making better progress now but has been slowed down by snow on its Transcontinental Gas Pipe Line Corporation job in Virginia, between Chatham and the Potomac River. The section consists of 196 miles of 30-in. The field office is at Altavista, with C. C. Craig spread superintendent and Ben L. Mapes office manager.

The company recently contracted through Brown and Root, agents, to lay 108 miles of 16-in. for Texas Eastern Transmission Corporation between Baytown and Provident, Texas. Right-of-way work is expected to get under way soon but pipe perhaps will not be received until the latter part of June due to strikes in the steel mills.

Parkhill Truck Company, Box 1856, Tulsa, Oklahoma, (stringing contractors), has contracted for the string of 1444 miles of pipe line:

Stringing 240 miles for Anderson Brothers Construction Company from Duluth, Minnesota, to Gretna, Manitoba, Canada, on the Interprovincial Pipe Line Company.

Unloading and stringing 196 miles of 30-in. in Virginia for Smith Contracting Corporation on the Transcontinental Gas Pipe Line system.

Stringing 109 miles of 22-in. for Britton Construction Company in Kentucky on Mid-Valley.

Stringing 120 miles of 20-in. for the Mahoney Contracting Company on the Mid-Valley line covering the work from the Ohio River to Lima, Ohio, the terminal point of the system.

Unloading and storing 240 miles of 8-in. pipe for Salt Lake Pipe Line Company for products line from Boise, Idaho, to Pasco, Washington. Beginning about June 1 the pipe will be strung between Boise and Baker, Oregon, (120 miles) for Morrison Knudsen Company, Macco Corporation, and Bechtel Corporation; and from Baker to Pasco, (120 miles) for Pacific Pipe and Engineers, Ltd.

Stringing 105 miles of 12-in. for Deaton and Sons on the Montana Power Company line from Bozeman to Butte, Montana.

Stringing 200 miles of 26-in. on Northern Natural Gas Company line in Nebraska, Iowa, and Minnesota, 100 miles for Midwestern Constructors, Inc., and 100 miles for Mary Construction Company.

Stringing 234 miles of 12-in. for Pacific Pipe and Engineers, Inc., on the Great Lakes Pipe Line Company system between Tulsa, Oklahoma, and Kansas City, Missouri.

Anderson Brothers Construction Company, 707 North Drennan Street, Houston, Texas, expects to begin work in May on the line between Gretna and Superior on Interprovincial Pipe Line Company's system. At the present time it is laying 193 miles of 18-in. crude oil line for Humble Pipe Line Company from Satsuma, Texas, to a point between Fredericksburg and Llano. This work is scheduled for completion in May.

Texas-Southern Contracting Company (formerly O. C. Whitaker Company), 804 Dan Waggoner Building, Fort Worth, Texas, has contracted Section D of the Transcontinental Gas Pipe Line Corporation system, the section from the west bank of the Sabine River to Humble, Texas. The work will not get started until sometime in July due to delay in receiving pipe.

Deaton and Sons, Inc., P. O. Box 2928, Odessa, Texas, began April 10 to lay pipe between Bozeman and Butte, Montana, for the Montana Power Company—83 miles of 12¾-in. W. F. Deaton is spread superintendent, H. H. Franklin office manager, and S. M. Scalf pipe foreman. When this job is completed 21 miles of 12¾-in. pipe will be laid for the same company from Billings, Montana, to the Wyoming border.

Latex Construction Company, 2707 Ferndale Place, Houston, Texas, announces the following work:

For Mid-Valley Pipeline Company, 41 miles of 20-in. crude oil line from Haynesville, Louisiana, to the Red River near Benton, Louisiana. Job to start about April 15, with headquarters at Haynesville.

For Mid-Valley, 18 miles of 12-in. crude oil line near Lake Providence, Louisiana. This work is to complete the lateral from Delhi to the main line at the Mississippi River. W. H. Hayes, superintendent; J. C. Strickler, office manager; headquarters, Lake Providence, Louisiana. Preliminary began April 3.

For Tennessee Gas Transmission Company, 123 miles of 30-in. gas line. Ninety miles of this work is from vicinity of West Monroe, Louisiana, to a point near Many, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler, and J. B. Stoddard, office; initial headquarters to be Jonesboro, Louisiana. Preliminary work on this section is expected to start in April. The second section of this job is 33 miles from Jones, Louisiana, to the Mississippi River to be done later.

For Tennessee Gas, 54 miles of 16-in. and 12-in. from Kinder, Louisiana, to Grand Chenier, Louisiana. F. A. Silar, superintendent; W. A. Briley, assistant superintendent; C. V. Oliver, office manager; headquarters, Kinder, Louisiana.

For Tennessee Gas, 95 miles of 20-in. from Natchitoches, Louisiana, to Kinder, Louisiana. F. A. Silar, superintendent; W. A. Briley, assistant superintendent; C. V. Oliver, office manager. Preliminary work to start in May but pipe expected about July 1.

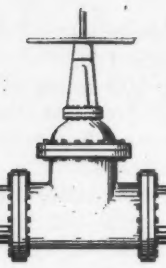
For Transcontinental Gas Pipe Line Corporation, 85 miles of 4-in. to 14-in. gas gathering system in South Louisiana. One spread began work April 1. J. B. Latham, superintendent; W. E. Bayles, office manager; headquarters, Vinton, Louisiana. A second spread will start as soon as pipe is available.

Fred Mannix and Company, Calgary, Alberta, Canada, will lay as a joint venture with **Canadian Bechtel, Ltd.,** 441 miles of 20-in. crude oil line from Edmonton to Regina for Interprovincial Pipe Line Company, being scheduled to get under way in May. Also scheduled to begin in May is construction of a part of the 18-in. line that will parallel the existing system between Portland and Montreal of the Portland Pipe Line Company and the Montreal Pipe Line Company.

Associated Pipe Line Construction, Inc., 4001 Homestead Road, Houston, Texas, will begin in May laying a part of the line between Portland and Montreal for the Portland Pipe Line Company and the Montreal Pipe Line Company. This will be 18-in. pipe. The two companies are paralleling their existing 12-in. system. The contractor has begun construction of 74 miles of the Transcontinental Gas Pipe Line Corporation system, the section from the Potomac River in Virginia to the Susquehanna River in Pennsylvania.

Mary Construction Company, Box 205, Cape Girardeau, Missouri, will begin work about June 1 on 111 miles of 26-in. for Northern Natural Gas Company. The section will loop the company's line from a point near Ogden, Iowa, to Farmington, Minn.

PIPE LINE PROJECTS



Southern Natural Gas Company Asks To Expand

The Federal Power Commission began a hearing to start April 4 in Washington, D. C., on the application of Southern Natural Gas Company, of Birmingham, Alabama, for authorization to expand its natural gas transmission system, which serves markets in Alabama, Georgia, Louisiana, and Mississippi.

The proposed program includes the construction of main line additions, branch line loops and connecting lines in Texas, Louisiana, Mississippi, Alabama, Georgia, and South Carolina, and a new high pressure line extending from the Gwinville (Mississippi) gas field to Aiken, South Carolina.

Construction of the proposed facilities, estimated to cost $32,928,630, would increase the capacity of Southern Natural's pipe line system by 109,000,000 cu ft per day to a total daily capacity of 529,000,000 cu ft.

Texas Eastern Contracts Gas Supply to Algonquin

Texas Eastern Transmission Corporation has concluded a contract with Algonquin Gas Transmission Company for the delivery of up to 250,000,000 cu ft of natural gas a day for resale by Algonquin to utilities in the New England area.

Texas Eastern and Algonquin have applied to the Federal Power Commission for authorization to construct the necessary facilities to serve the New England area. Hearings on the two applications are expected within the next few months. If favorable action is taken by the FPC, actual construction can begin by the end of the year so that deliveries of gas may be started in time for the winter heating season of 1951-52, Texas Eastern said.

Required new facilities to be added to the Big Inch and Little Big Inch system would cost approximately $60,000,000, Texas Eastern estimated. The pipe line system that Algonquin proposes to construct from a delivery point on the Big Inch system near Lambertville, New Jersey, to serve substantially all the gas distributing companies in the New England area would cost about $27,000,000.

In addition to serving the needs of Algonquin, Texas Eastern proposes to deliver additional quantities of gas to some of its present customers in its existing service area. Texas Eastern's plan contemplates delivery from new sources of supply from Southwest gas fields and use of underground storage in depleted Appalachian fields near the company's present lines. Underground storage will afford balancing operations between heavy demands of the winter heating season and the off-peak demands of the summer season, Texas Eastern explained.

Transcontinental Will Substitute Pipe Sizes

The Federal Power Commission has permitted Transcontinental Gas Pipe Line Corporation, Houston, Texas, to substitute different pipe sizes on certain sections of its previously authorized Texas-to-New York City pipe line project.

The substitutions include 30-in. pipe to replace the 26-in. pipe authorized on 104 miles of line extending from Chester Junction, Pennsylvania, to Paterson Junction, New Jersey, adding an estimated $1,295,778 to the cost; 258 miles of 30-in. pipe to replace 26-in. pipe between Markham field, Texas, and Opelousas, Louisiana, at an estimated additional cost of $2,863,961; 24-in. for the 26-in. pipe authorized on a 107.3-mile section in Texas between the La Gloria lateral and a point near the St. Charles lateral, at a saving of $986,655 in the overall project cost; 41.3 miles of 14-in. pipe for the 20-in. pipe authorized between the Sun lateral and the La Gloria lateral in Texas, saving an estimated $554,161; and 10-in. pipe for the 20-in. pipe authorized on a 36.4-mile section between the Lacy field and the Sun lateral, in Texas, at an estimated saving of $799,459.

Two Lines Proposed From Redwater To Edmonton

Interprovincial Pipe Line Company has made application to the Canadian Board of Transport Commissioners for permission to construct a line between Redwater and Edmonton.

British American Oil Company also has announced plans for a pipe line from Redwater to Edmonton. This line will have a capacity of 10,000 bbl a day and is expected to be completed by the end of the year.

East Tennessee Proposes Extension To Bristol

East Tennessee Natural Gas Company, of Chattanooga, Tennessee, has filed an application with the Federal Power Commission proposing to increase the delivery capacity of its pipe line system by 40,000,000 cu ft of natural gas per day through the construction of approximately 139 miles of pipe line extending from a point south of Knoxville to Bristol, Tennessee.

The proposed facilities, estimated to cost $5,264,120, would provide natural gas service to the markets and areas extending from Oak Ridge to Bristol, including Mascot, Jefferson City, Morristown, Johnson City, Elizabethton, Kingsport, and Bristol, all in Tennessee.

The construction program includes 100 miles of 16-in. line, 21 miles of 6⅝-in. line, 18 miles of 8⅝-in. line, and a 1400-hp compressor station. East Tennessee expects to obtain its required additional gas supply from Tennessee Gas Transmission Co.

East Tennessee last spring was authorized by FPC to construct a pipe line for transportation of 60,000,000 cu ft of gas a day to the Atomic Energy Commission's Oak Ridge, Tennessee, plant. The company's original application in that proceeding proposed the Bristol extension, but the plan was withdrawn in an amended application filed before hearings were held.

Panhandle Eastern Seeks To Boost Its Gas Supply

Panhandle Eastern Pipe Line Company has outlined to the Federal Power Commission plans to increase its gas supply by 300,000,000 cu ft a day. By purchasing the entire delivery of a proposed Louisiana-to-Illinois pipe line, 250,000,000 cu ft would be obtained. The other 50,000,000 cu ft would be made possible by expansion of Panhandle Eastern's existing facilities in the Hugoton-Panhandle area of Kansas, Oklahoma, and Texas.

Robert P. Patterson, chief attorney for the company, said the expansion would raise the company's daily supply to 800,000,000 cu ft. The additional gas would be sold principally in the Midwest.

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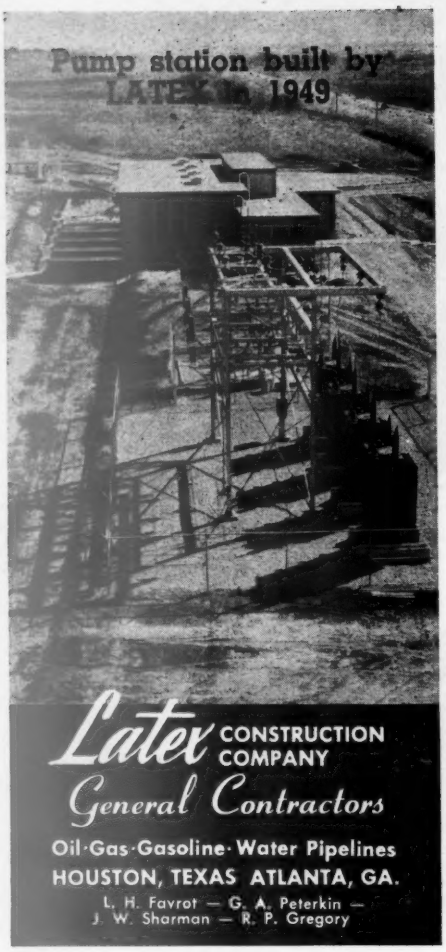

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Projects

Texas-New Mexico Plans New Line

The Texas-New Mexico Pipe Line Company will construct a 10-in. pipe line approximately 37 miles in length in West Texas through the Kelly Canyon and North Snyder pool into the southwest section of Kent County, it was announced by R. B. McLaughlin, president of the pipe line company.

The crude oil line will begin at the Basin Pipe Line System's Colorado City station in Mitchell County and extend through Kelly Canyon and North Snyder pools in Scurry County, and to the southwest section of Kent County.

Specifications are being prepared, and a contract for construction of the pipe line will be awarded soon.

In addition to the main trunk line, the company will install gathering line facilities in the Kelly Canyon and North Snyder pools and in the southwest section of Kent County.

Interprovincial Pipe Line Capacity May Be Increased

The initial capacity of the Interprovincial Pipe Line Company, extending 1150-miles from Edmonton, Alberta, Canada, to Superior, Wisconsin, may be increased by 50 per cent over that originally planned, according to Dr. O. B. Hopkins, president. Hopkins said consideration is being given to increasing the capacity to 135,000 bbl a day from the presently planned 95,000 bbl a day. This would be done by constructing 12 pumping stations instead of six.

The increased capacity is being considered because of the growing production of western Canada's oil fields. At the present time production is being limited to approximately 70,000 bbl a day in Alberta, which is about all the oil that existing markets can absorb in western Canada. Alberta's potential production, however, is estimated as high as 125,000 bbl a day.

United Gas to Spend $36,000,000 This Year

An expenditure of nearly $36,000,000 is planned by the United Gas companies in 1950 to expand and improve facilities in the Gulf South states in which they operate, according to an announcement by N. C. McGowen, president.

Almost 34,000 homes, stores, and factories will obtain natural gas service for the first time as a result of construction this year by the distribution divisions of United Gas Corporation. Many of these new customers will be in cities and towns presently served by the firm, while others will be in communities previously without gas service. Nearly $7,500,000 is provided in the 1950 construction budget for extensions of gas service by the distribution divisions of the company.

United Gas Pipe Line Company, the transmission subsidiary, contemplates construction expenditures of nearly $22,000,000 during the year. Approximately $2,000,000 will go into gathering lines and equipment to tie additional gas fields into the pipe line system. About $17,500,000 is scheduled for construction of new lines to communities and industries not presently served and to increase the capacity of existing transmission lines. The remainder of the pipe line company construction budget will go into plants for the production of natural gasoline and other liquid hydrocarbons from natural gas, for expansion of compressor stations, and other projects.

Union Producing Company, the producing subsidiary of United Gas Corporation, has a budget of nearly $6,500,000 for acquisition of leases, exploratory drilling, gas and oil field development and recycling operations, including the drilling of about 50 wells in the Gulf South area.

United Gas, with general headquarters in Shreveport, invested more than $36,000,000 in extensions of service and development of oil and gas fields during 1949, it was pointed out by President McGowen. This year's construction budget will bring the total spent on similar projects since 1930 to more than $300,000,000.

Pipe Line System in Carolinas is Proposed

Carolina Natural Gas Corporation, of Charlotte, North Carolina, has applied to the Federal Power Commission for authorization to construct a system of lateral pipe lines to supply natural gas to distributors now serving manufactured gas in communities in North and South Carolina.

The company at the same time asked the commission to order Transcontinental Gas Pipe Line Corporation to connect its transmission system with the proposed lateral pipe line system and to sell natural gas to Carolina Natural.

Carolina Natural is proposing to construct approximately 372 miles of pipe line, consisting of 18 lines having an aggregate design capacity of 140,000,000 cu ft per day. The lines would extend laterally from Transcontinental's main transmission line to the various Carolina markets proposed to be served.

Texas-Illinois Line To Cost $117,000,000

Robert G. Strong, chief engineer of the Texas-Illinois Natural Gas Pipe Line Company, told the Federal Power Commission recently that the proposed 1300-mile line from the Corpus Christi area of South Texas to Joliet, Illinois, would cost $117,000,000 to build. The gas would be collected from the Chocolate Bayou, Old Ocean, and La Gloria fields and would converge into a 30-in. line south of Houston, he said.

The gas is needed to supplement that brought to the Chicago area by the Natural Gas Pipeline Company of America from Texas Panhandle fields, it is contended. The applicant and the latter company are both subsidiaries of Peoples Gas Light and Coke Distributing Company.

New Lines Across Mississippi Authorized

The Federal Power Commission has authorized Tennessee Gas Transmission Company, of Houston, Texas, to install four 26-in. pipe lines on the Mississippi River highway bridge at Greenville, Mississippi, and an additional 28,800 ft of 26-in. line to connect the bridge crossing with the company's natural gas transmission system on both sides of the river.

Installation of the four pipe lines will involve replacing the existing concrete slab high on the bridge and reinforcing the present bridge structure so as to provide sufficient load carrying capacity. Estimated cost of the project, including the bridge reinforcement program, is $2,355,880.

Tennessee's entire deliveries are now transported through two 18-in. pipe lines on the Greenville bridge, and two 16-in. submerged pipe lines near the Greenville bridge and are inadequate for the river crossing, the company said. The four additional lines are necessary to transport the proposed daily gas volumes that will be delivered at the river crossing upon completion of new pipe line facilities now under construction.

The Commission previously had authorized Tennessee to construct an aerial suspension bridge capable of supporting three 26-in. pipe lines; however, Tennessee stated that since the time of that authorization, in August, 1947, the cost of constructing the aerial suspension bridge has increased from $3,618,900 to $10,675,000, and that the present plan will permit a more feasible operation than the suspension bridge. Four new lines will assure uninterrupted service, the company said.

Speed Action in Transcontinental Case

The Federal Power Commission has ordered intermediate decision procedure omitted in the proceedings involving applications of Transcontinental Gas Pipe Line Corporation, which is proposing to expand the capacity of its Texas-to-New York City pipe line, and South Jersey Gas Company, which is seeking authorization to build pipe line facilities in New Jersey to receive gas from Transcontinental.

The case will now go directly to the commission for decision without the filing of an intermediate decision by the Presiding Examiner.

The action was requested by both applicants. Transcontinental said that it needed the authorization early in 1950 in order to carry through its integrated construction program, to avoid delays, to take advantage of favorable prices for pipe and compressor station engines, and to satisfy the requirements of its contracts.

Transcontinental is proposing to increase the capacity of its Texas-New York City pipe line by 165,000,000 cu ft per day to a new total of 505,000,000 cu ft. South Jersey is seeking authorization to build 77 miles of line designed to carry about 30,000,000 cu ft daily. The company plans to receive about 18,000,000 cu ft from Transcontinental in the first year.

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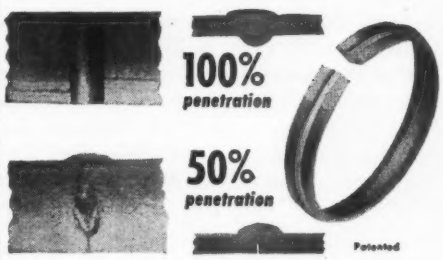

part of the line—in case of shock, strain or vibration the PIPE will fail before the reinforced joints. WEDGE Chill Rings enable you to weld faster with less labor. You can safely use thin wall pipe at substantial savings in the cost of pipe, shipping and laying.

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WEDGE PROTECTORS, INC.

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WEDGE Split CHILL RINGS SAVE MONEY

PICTORIAL

Cottages at North Waterford, Maine, pump station, of Portland Pipe Line Corporation.

Executive Committee, Southwestern Gas Measurement Short Course, which met in Norman, Oklahoma, April 11-13: Sitting, Ray L. Rountree, United Gas Pipe Line Company, Shreveport, Louisiana; Max K. Watson, Natural Gas Consultant, Amarillo, Texas; W. H. Carson, Dean, College of Engineering, University of Oklahoma, Norman. Standing: Earl Kightlinger, Alabama-Tennessee Gas Company, Florence, Alabama; R. M. Scofield, Lone Star Gas Company, Dallas, Texas; E. C. McAninch, Oklahoma Natural Gas Company, Ardmore; and C. E. Terrell, Southern Natural Gas Company, Birmingham, Alabama.

General Committee, Southwestern Gas Measurement Short Course: Sitting, George E. Greiner, Phillips Petroleum Company, Bartlesville, Oklahoma; Ben F. Worley, United Gas Corporation, Shreveport; Miss Kate A. Niblack, Oklahoma Utilities Association, Oklahoma City; W. H. Woods, Gulf Oil Corporation, Houston; Dean W. H. Carson; T. S. Whitis, West Texas Gas Company, Lubbock, Texas. Standing: J. W. Sanders, Arkansas Oil and Gas Commission, El Dorado; E. L. Stark, The Foxboro Company, Dallas; W. A. Brewster, Arkansas Louisiana Gas Company, Shreveport; Pat H. Miller, Texas Eastern Transmission Corporation, Shreveport; T. J. Kirkpatrick, Panhandle Eastern Pipe Line Company, Kansas City, Missouri; J. H. Satterwhite, American Meter Company, Inc., Tulsa; M. D. Gilbert, Pittsburgh Equitable Meter Division, Rockwell Manufacturing Company, Tulsa; Dean Bruce, Oklahoma Natural Gas Company, Tulsa; Roy S. Peace, Jr., Southern Natural Gas, Birmingham; Roland O. Cox, Lone Star Gas Company, Dallas; and James L. Griffin, Northern Natural Gas Company, Omaha, Nebraska.

GENERAL NEWS

1949 Oil Incomes High But Below 1948 Earnings

Earnings in 1949 were below the records of 1948 for most oil companies, according to their annual reports. Continental Oil Company, Ponca City, reported net earnings of $36,096,880, compared to $54,216,729 for 1948.

Shell Oil has reported net earnings of $76,423,000 comparing with $111,396,000 in 1948. During the year, the company built a paraffin wax plant, enlarged its refineries and chemical plants, and built new shops, etc., at Houston, Texas.

Skelly Oil, Tulsa, Oklahoma reported a net income of $26,186,500 as compared with $38,914,350 reported in 1948. Skelly completed a catalytic cracking unit at its El Dorado, Kansas refinery, expanded its marketing facilities, and built several gasoline plants during the year.

Pure Oil Company netted its second largest income in 36 years during the year 1949, the company's annual report states. Net income for the year amounted to $26,977,116, which compared with $41,672,136 for 1948, a 35 per cent decline. Pure Oil's crude oil reserves are larger than at any previous time in its history, the company reported.

Kirby Petroleum Company reported gross earnings for the company declined 7.2 per cent during the year, while net earnings were 23.7 per cent lower, due mainly to increased exploratory expenses. The company spent $388,186 in drilling, or participating in the drilling of 19 exploratory dry holes in Arkansas, Louisiana, Mississippi, Texas, and Canada. Drilling and equipment of oil and gas wells amounted to a total of $601,476.

Standard Oil Company (Indiana) has reported that total sales were down 6.7 per cent in 1949 compared to 1948. Product sales were up 3 per cent in volume, but prices were about 4 per cent lower on the average. Net earnings for the year were $102,668,228. In 1948 the income totaled $140,079,286.

Cities Service Oil Company's annual report states that net current assets exceeded $180,500,000, the highest in history, during the year 1949. Consolidated earned surplus increased more than $70,000,000 to a record high of $243,600,000. Cities Service net income for 1949 was $55,057,822, compared with $65,779,039 in 1948.

IOCC to Hold Spring Meet

The Interstate Oil Compact Commission is planning its spring quarterly meeting in the Buena Vista Hotel, Biloxi, Mississippi, May 4-6. The legal committee will make a study of the conservation activities in the states during 1949 and present its findings at the spring meeting. The proposed book of engineering principles will be presented by the engineering committee in final form, and other committees will report on their activities.

British visitors get acquainted with American designed equipment they have just become licensed to build and sell abroad. On engine platform is Peter Letz, Copper-Bessemer works manager, with Edward Moller, assistant chief draftsman of Harland and Wolff, Ltd. In foreground (left to right), are Jack Martin, Harland and Wolff assistant foundryman; David Mathews, Harland and Wolff assistant works manager; and I. W. Ferguson, Cooper-Bessemer assistant works manager.

British Firm To Build "V" Angle-Type Compressors

A contract recently concluded between The Cooper-Bessemer Corporation and Harland and Wolff, Ltd., world-noted British shipbuilder and engine manufacturer, now licenses Harland and Wolff to build Cooper-Bessemer "V" angle-type compressors abroad. The compressors covered by the contract are the Cooper-Bessemer type JM motor-driven units, and the GMX, GMV, and GMW "V" angle-type gas engine-driven units, according to Gordon Lefebvre, president of The Cooper-Bessemer Corporation, Mt. Vernon, Ohio.

"Under the terms of our agreement, Harland and Wolff is to manufacture and sell our compressor line to many of the countries now included in the sterling area," explained Lefebvre. "The areas include the United Kingdom, British Dominions and Commonwealth (excluding Canada), colonies, possessions, protectorates, and mandated territories of Great Britain. Included also is the European continent, Iran, Kuwait, Iraq, Turkey, Syria, Lebanon, India, Pakistan, Burma, all of South America (excluding Venezuela, Colombia, Peru), the French Colonial Empire, Egypt, and Israel. Our agreement with Harland and Wolff, however, stipulates that Cooper-Bessemer reserves the right to continue to sell direct to such companies as are now located in the Harland and Wolff area but whose purchases are engineered and contracted for in this country."

The agreement with Harland and Wolff, approved by the British Ministry of Supply, further stipulates that royalty payments to Cooper-Bessemer will be made in dollars.

A group of Harland and Wolff personnel is now in this country to become acquainted with Cooper-Bessemer's designs and manufacturing procedures. Tooling and production of GMV-6 compressor units already on order for Trinidad Lease Hold, is to start immediately.

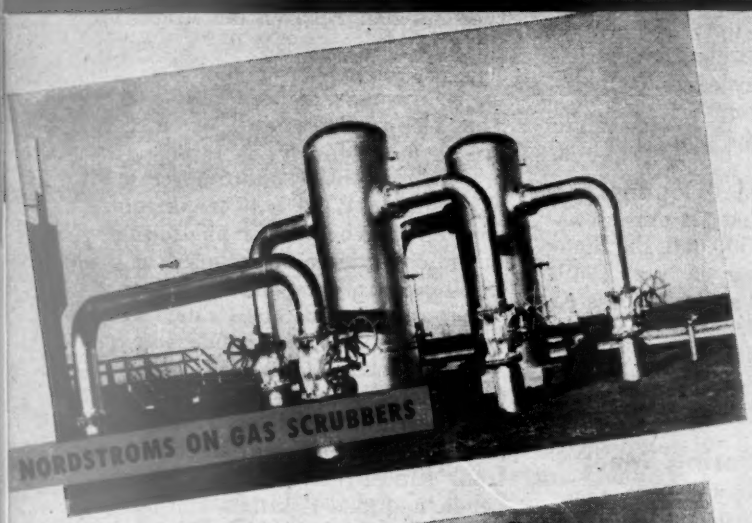
Educational Refund Plan Participants Increase

Employee participation in an educational refund plan sponsored by the Socony-Vacuum Oil Company, Inc., increased 22 per cent during 1949, the company has announced. The number of participants rose to 337, compared with 276 in 1948.

Under the plan, the company pays half the cost of tuition and related expenses, up to $75 per semester or $150 in any 12-month period, for advanced study on the employees' own time at approved schools and colleges.

PERFORMANCE MAKES PREFERENCE

IN EVERY GAS APPLICATION, USE NORDSTROMS



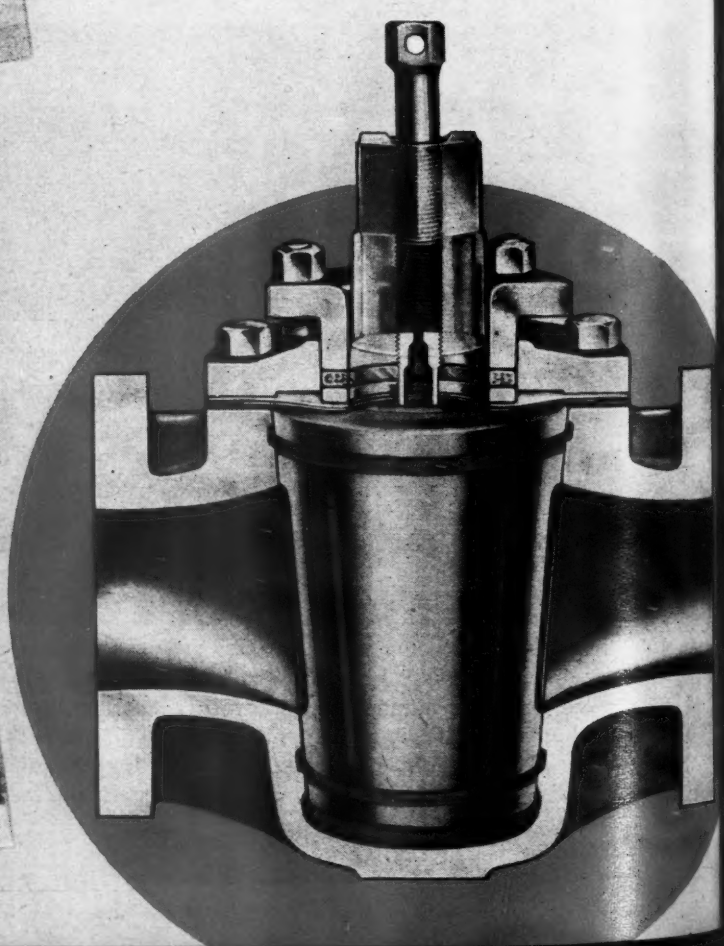
NORDSTROMS ON GAS SCRUBBERS

NORDSTROMS ON A 26" MAIN LINE

NORDSTROMS IN METERING & REGULATION STATION

NORDSTROMS IN DEHYDRATION PLANT

PERFORMANCE comes first. The Nordstrom record speaks for itself. They will out-wear, out-last and out-perform any other valve, as proved by comparisons in every phase of gas handling, from well to consumption. And now, with the advent of Hypermatic, Nordstroms are automatically lubricated, so that still further economy is made in maintenance time. The valves are kept in a 100% lubricated condition which means a more effective guard against leakage, easier operation and more positive control, with less time and lubricant used in servicing.



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NORDSTROMS AT BORDER CONTROL

NORDSTROMS ON COOLING TOWER MANIFOLD

NORDSTROMS ON COMPRESSORS

GENERAL NEWS

Crude Oil Flow Rate Raised In Four Different States

Texas, Louisiana, Oklahoma, and Kansas are producing more crude oil this month than last, due to higher allowables in each of the four states.

Texas' permissible crude production received a sharp boost, when the Texas Railroad Commission set the April limit by 130,376 bbl a day over the March quota, making the total a set maximum of 2,088,722 bbl per calendar day.

A hike in Kansas production of crude oil in April amounted to 5000 bbl daily, making a total allowable of 275,000 bbl. This new figure was set after three months at 270,000 bbl a day.

April figures for Louisiana's daily allowable were increased only slightly. During the month of April this state will produce 536,528 bbl per day, compared to March's quota of 534,869 bbl. The small increase was due mostly to new production, it was stated.

Oklahoma may produce 447,628 bbl of oil daily this month, compared to March's limit of 407,273 bbl daily.

Chile Wants Sterling Oil

Chile has announced that she would rather have Britain and American oil companies supply oil products from sterling or other non-dollar areas, as she wants to use her dollars to buy machinery in the U. S., *The Petroleum Times* has reported. Dollars that are now being spent for oil in Aruba, Curacao, and Peru do not benefit the U. S., a Chilean official stated. A scheme is being worked out, he added, which would save about $15,000,000 a year now being spent on oil.

Pemex Crude Oil Output Up

Petroleos Mexicanos, the Mexican government oil monopoly, has reported that its crude oil production rose to daily average of a little over 170,000 bbl a day in 1949, from 160,350 bbl daily in 1948. By the end of 1949, daily oil output of Pemex was up to 196,500 bbl; total production last year was 62,097,308 bbl, up from 58,529,201 bbl in the previous year. Daily output of natural gas was 164,000,000 cu ft.

Record Radio Schedule

The Atlantic Refining Company has announced that it will have the largest baseball radio coverage in its 15th consecutive year of sponsoring these broadcasts. All of the home games of the Philadelphia Athletics and Phillies will be covered and televised.

Equipment Suppliers Have Big LA Meeting

The California chapter of the Petroleum Equipment Suppliers Association staged an all day meeting in the Los Angeles Ambassador, recently, that had everything such a meeting should have, and quite a bit over. Under the direction of Ted Sutter, California chairman, it was a well attended, smoothly functioning affair. The opening event was the projection of a color motion picture of Argentina and other South American republics by S. W. "Big Web" Webster, Emsco Derrick and Equipment, Houston, Texas.

Then began the business session, the purpose of which was obviously education—the promotion of a fuller understanding of the structure of PESA and its aims and objectives. It accomplished all of that in a very marked degree, for if there were those who lacked knowledge of the institutional set-up and purpose when they arrived, they could hardly have failed to find positive answers to their questions in the succession of informative talks that made up the afternoon program.

Ted Sutter, chairman, did an excellent job, not only in the arrangement of the program, but in the more meticulous matters of timing and direction. His own address was an exposition of the fundamental reason for the existence of the PESA; what it has currently to offer to its members; and what advantages are yet to accrue to members who avail themselves fully of their privileges as members.

J. A. "Jack" Crawford, president of Youngstown Steel Products Company, waxed reminiscent in his talk, and sketched the history of PESA most interestingly from its first beginnings to the present time. He is well qualified to do so, having officiated as chairman of the original organizing committee, and meantime having been particularly active in the development and growth of the Association throughout its life. He recited some of the heart-breaking misfortunes by which the pioneer proponents of the PESA idea were badly discouraged but not deterred, and he closed with an urgent plea for an expanding interest and more generous participation in Association affairs by member firms.

Bob Safford, national secretary, made a fine impression on the assembly with his concise report on what the Association has done specifically both for the industry as a whole and for its individual members. He reeled off his story of accomplishment with no hesitancy and it hit the mark in no uncertain way. Then followed short but punchy talks by Jack Pike, president, Republic Supply; Rodney Durkee, president, Lane-Wells; E. S. Dulin, president, Byron Jackson; D. S. Faulkner, president National Supply; Hugh Glen, president, Emsco Derrick; Warner Parker, general sales manager, Oil Well Supply; and W. A. Miller, secretary-treasurer, Lane-Wells.

At the close of the business meeting, the gathering repaired to the Embassy Room for cocktails, after which an excellent dinner was served and the remainder of the evening given over to relaxation. A professional pickpocket created a near panic in the dining room with his wholesale pilfering, but before the evening was over had restored everything to the rightful owners and had made a lot of fun in the process. Altogether it was a meeting to remember, and to Ted Sutter went the thanks and congratulations of everyone present for his capable handling of the affair.

Offers Safety Training Course

The University of Michigan school of public health is offering an inservice training course in industrial hygiene and human relations for safety personnel June 19, 20, and 21. The course is designed for the benefit of safety personnel, which includes anyone responsible for safety. In smaller plants this might mean the manager or owner himself, however, other persons interested in the subject matter to be presented are welcome to attend, the university reports.

Fire Prevention Group Meeting

Safe practices in cleaning and ventilating tanks, fire protection regulations, and visual aids in the petroleum industry are among the many subjects that will be discussed by the American Petroleum Institute's central committees on accident prevention and fire protection at their mid-year meeting. The sessions will be held in Atlantic City, New Jersey, concurrently with the annual meeting of the National Fire Protection Association, May 15-18.

Industrial Research Meeting to Be Held

The department of industrial engineering of Columbia University, New York City, will conduct a five-day conference on the Costs, Budgeting, and Economics of Industrial Research from June 12 through June 16 of this year. Experts from industry and the university will participate in lectures, discussions, and clinic sessions designed for the practical research and development administrator.

Above, mobile driver education unit arrives at an Humble camp.

Driver-instructor C. E. McDonald checks W. W. Morris as he lines up miniature cars in the distance judgment phase of the driver program.

Mobile Driver Training Unit Is Set Up By Humble Oil

A mobile driver education unit, recently put on the road by Humble Oil and Refining Company and Humble Pipe Line Company, is making testing equipment and instruction available to Humble drivers in isolated field locations. It is part of a program to give every company employee who drives an assigned company car or truck or who at any time has authority to drive a company vehicle the opportunity to evaluate his own driving.

The large trailer of the mobile unit is divided into two main compartments —a testing room and an interview room—and is equipped to give the complete driver education course. C. E. McDonald, driver-instructor of the mobile unit expects to aid 40 drivers evaluate their own driving each week.

The first phase of the driver education program is an examination of visual skills and reaction time. Next, a written examination is offered to see how much the driver knows about traffic laws, safe driving practices, and certain mechanical phases of vehicle operations.

The third phase of the program includes driving skill evaluation. This is actual operation of a vehicle over an "obstacle course." Following the completion of these three phases, the instructor reviews the results with the driver in private.

Giddens Gives History of Oil

"The Birth of the Oil Industry" by Paul H. Giddens is published in the 1950 winter issue of the *American Heritage*. Illustrated with sketches of the early days of oil, and other pictures, the article is the story of the discovery of oil at the Drake well in Titusville, Pennsylvania some 91 years ago. Giddens is the curator of the Drake Well Memorial Park.

OIIC Holds Workshop Meet

District offices of the Oil Industry Information Committee are currently engaged in holding a series of meetings to give local committeemen a detailed picture of the 1950 OIIC program. Theme of the meetings is "You've Got A Story—Start Telling It Now." A special leaflet has been prepared by the OIIC editorial department and is being distributed at these meetings.

Sun Answers Court Charges

Sun Oil Company, which is being charged with anti-trust law violations in the sale and distribution of gasoline and automobile accessories, has prepared a 157-page document in answer to requests by Attorney General J. Howard McGrath. The document listed the year-by-year sales volume of gasoline, lubricants, and automotive accessories of the company in each of 18 states and the District of Columbia for the period 1929 to 1949 inclusive, and provided other information.

Of 16 requests for information filed by the attorney general's assistants only one question was left unanswered. This was the demand for the names of dealers whose contracts were terminated against their wishes. The company asserted it "has no compiled records from which it can supply" this information.

Milam Is 40-Yr. Employee

The Cities Service Gas Company's Employee News Letter reports that H. B. "Bert" Milam has worked continuously for the company since February 15, 1910. Milam, a young Kansas sailor back in 1910, stopped off at the Cambridge compressor station of Cities Service to visit a brother, and while there, accepted a temporary job. The temporary job stretched into 40 years of continuous employment when Milam reported for work in Wichita, Kansas on the same date this year. He is now superintendent of gas transportation for the Cities Service pipe line system.

Technical Reports Available From Commerce Department

Three hundred and thirteen technical documents, most of them available to the American public for the first time, are listed in the current issue of the Bibliography of Technical Reports, now available from the Office of Technical Services of the U. S. Department of Commerce. The documents, all accompanied by abstracts or subject catalog descriptions, are derived principally from federal or federally sponsored research. Technical reports covering a wide range of subjects from Germany, Russia, Britain, Canada, France, Sweden, Japan, and Italy are also included.

PERSONALS

▸ **H. W. Haight,** has been elected executive vice president of the Creole Petroleum Corporation. He has been active in the oil industry since May, 1927, when he joined the Cia. Transcontinental de Petroleo, South America, an affiliate of the Standard Oil Company (New Jersey), as a torsion balance helper.

He subsequently served as a geologist with this same company and in 1937 was transferred to the Standard Oil Company of Egypt as field superintendent. A year later he became manager and chief geologist of that company. Haight joined the Creole Petroleum Corporation in 1945 and was elected vice president and director of the company in charge of the company's operations in Venezuela in June of the following year.

▸ **H. J. Struth,** petroleum consultant of Dallas, Texas, has just accepted an assignment as petroleum consultant to the Venezuelan Government. He is leaving immediately for Caracas, where he will organize a petroleum statistical department for that government, and will prepare an economic survey of the Venezuelan petroleum industry.

His initial assignment will keep him in Venezuela for a period of about three months, after which he will return to Dallas to resume his consulting and advisory services for various American petroleum organizations. Before his departure for Venezuela,

H. J. Struth

Struth stated that he will probably make frequent future trips to that country in the interests of his work.

Struth recently returned to Dallas from New York, where he was assistant director of information for The American Petroleum Institute. He was formerly associated with The Texas Mid-Continent Oil and Gas Association, as economist and executive assistant, and later was editor of *The Petroleum Data Book*, published by *The Petroleum Engineer*.

NEW YORK NOMADS VISITORS—Foreign guests who attended a regular meeting recently of the New York Chapter of Nomads held at Louis Sherry's, Park Avenue, are, Front row: Paul W. Brower, Socony-Vacuum Oil, Bogota, Colombia; F. Padilla, PEMEX, Mexico City; Tom Conger, S.V.P.M. (Standard Vacuum), Palembang, Sumatra; E. Fabres, Fomento (Chilean Government), Santiago, Chile. Back row: C. A. Garcia, PEMEX, Mexico City; L. A. Messone, Y.P.F., Buenos Aires, Argentina; Elmer Weiss, Y.P.F., Buenos Aires, Argentina; Alberto Landoni, Y.P.F., Buenos Aires, Argentina; J. W. Deschamps, Hughes Tool Co. and Lucey Export Corporation, Buenos Aires, Argentina; F. Blanco, D.G.G.E., Buenos Aires, Argentina.

▸ **F. L. White** has been appointed an assistant treasurer of the Socony-Vacuum Oil Company, Inc. He has been associated with the company since 1934, and is a member of the class of 1933 at Dartmouth.

▸ **Joseph H. Mader** has been promoted to the post of assistant director of the Department of Information of the American Petroleum Institute. Mader has been district representative for the Oil Industry Information Committee in the Middle Atlantic district for the past three years. His headquarters have been in Philadelphia, Pennsylvania. **Ernest E. Robinson,** formerly director of public relations and personnel for the Don Allen Organization in Buffalo, New York, has been selected to succeed Mader in the Philadelphia office.

Another recent addition to the staff is **Jack McKenzie,** assistant to James S. Haskins, supervisor of field operations. McKenzie, prior to his OIIC affiliation was vice president in charge of the eastern operations of James W. Irwin Associates, a public relations consulting firm.

▸ **N. P. Isenberger,** vice president, The American Independent Oil Company, has resigned and is returning to the Phillips Petroleum Company from which he has been on loan.

▸ **E. N. Redden,** vice president and general manager of the Rinehart Oil News companies of Texas, Oklahoma, Louisiana, and Colorado, has tendered his resignation to the president, Mrs. B. D. Less. Redden joined the Rinehart organization in 1936 as editor and manager of "The Basin" in Midland. In 1938, he was made a director and stockholder and transferred to Houston. He was named vice president and general manager in 1948.

Don Turner, attorney and assistant secretary for Sohio, was named executive vice president and a director of the oil publishing companies. He will maintain headquarters in Dallas, Texas.

▸ Rocky Mountain Oil and Gas Association board of directors are: **Walter Davis,** Casper, Wyoming; **J. E. Regent,** Sun Oil Company, Denver, Colorado; **H. E. Thomson,** Amerada Petroleum Corporation, Casper; **H. I. Craig,** Bay Petroleum; **Gordon Kay,** Morton Oil; **Harold** Wyatt, Union Pacific Railroad Company, and **Harold Healy,** Ohio Oil, named to the executive committee.

William M. "Scotty" Jack has been named executive vice president of the Rocky Mountain Oil and Gas Association. Jack is a widely known former state official in Wyoming.

Floyd K. Beach has retired from the Petroleum and Natural Gas Conservation Board of Alberta, Canada. Prior to his connection with the Board, he occupied a similar post with

Floyd K. Beach

the Department of Lands and Mines, going to Alberta Government service from the Dominion Government in 1931.

During the early life of the Turner Valley field, when gas produced with oil was far in excess of market requirements and the surplus gas was flared, Beach organized systematic measurement of gas production in order to provide a record of remaining reserves. He edited the 1938 edition of the Schedule of Wells Drilled in Alberta for oil and gas, and has looked after subsequent editions, the most recent of which brings the record up to the end of 1949 and is now in the hands of the printer.

Beach plans to open an office as oil and gas consultant and pending location of a suitable office downtown, will work from his residence. He has published numerous technical articles in publications dealing with oil and gas, covering subjects dealing with measurement of gas, estimation of reserves, reservoir performance, etc., and since 1942 has placed an annual review of Canadian oil and gas in *The Petroleum Engineer*.

Harry D. Collier, civic leader and widely known oil man from Los Angeles, will lead the American Cancer Society's 1950 educational and fund raising drive in California as state chairman. Collier is chairman of the finance committee and a director of the Standard Oil of California.

William R. Marshall, general manager of The Atlantic Oil Storage Company, Antwerp, has been made a Knight of the Order of Leopold I in recognition of services rendered to the Belgian economy. The Atlantic Refining Company operates The Atlantic Oil Storage Company as its marketing subsidiary in Belgium. Marshall has been stationed in Europe for a number of years.

Joseph M. Nugent, manager of claims and insurance in the marine transportation department of the Socony-Vacuum Oil Company, Inc., was honored recently by company officials and fellow-workers with a luncheon in the India House, New York, on completion of 40 years of service with the company. He was presented with an engraved silver cigarette humidor.

Ivian A. Parmer, district superintendent in West Texas for Coronado Oil Company, Tulsa, Oklahoma, has been transferred to Elk City, Oklahoma, where he will serve as division superintendent for Oklahoma, Texas, and Kansas.

Fred A. Walters, assistant general manager in charge of manufacturing of the Socony Paint Products Compeny, Metuchen, New Jersey, has been promoted to vice president of the organization. He succeeds **C. G. Nelson** who retired January 1.

Walters attended New York University and started in 1912 with the Standard Oil Company of New York as a stenographer and statistician in the export department.

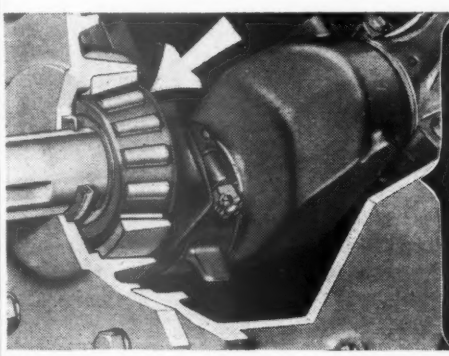
Earle S. Burnett has resigned after 27 years with the Bureau of Mines. He was a mechanical engineer and physicist at the Amarillo, Texas helium plant.

A graduate of the University of Wisconsin, Burnett gained his greatest recognition for his perfection of

Earle S. Burnett

an apparatus for determining the compressibility of gases. Used now by many natural gas companies for high pressure gas measurement, it has been termed "the outstanding contribution of the year in thermodynamics."

Burnett joined the Bureau of Mines in 1923, and after five months was transferred to Fort Worth, where he was employed at the U. S. Helium Production Plant. He went to Amarillo in 1929, and assisted in the design of the Amarillo Helium Plant.



Why WISCONSIN HEAVY-DUTY Air-Cooled ENGINES Run on Timken Tapered Roller Bearings

Ever since the first Wisconsin Air-Cooled Engine was built over 20 years ago, the crankshaft of every one of these fine engines has been supported by Tapered Roller Bearings at BOTH ENDS. Here's why:

1. Tapered Roller Bearings take up all *End Thrusts* and *Radial Loads* (impossible with other types of bearings). You can mount your drive directly on the extended crankshaft of any Wisconsin Engine without the need for an extra thrust bearing or outboard bearing.

2. Tapered Roller Bearings *resist wear* to a greater extent than other types of bearings not only because of the file-hard surfaces of Timken Tapered Bearings but also because these bearings are inherently SELF-CLEANING. Oil enters at the smaller end of tapered roller bearings and centrifugal force carries it out through the large end, thus preventing accumulations of dirt and sludge that is often present in the oil. (Tapered bearings cannot develop shaft-cutting abrasive surfaces.

3. Tapered Roller Bearings permit flexing of the crankshaft to a much greater degree than the longer, rigid plain bearings which cannot stand up under flexing conditions, resulting in wearing "bell-mouthed" or failing completely. We have yet to hear of a single case of Wisconsin Engine bearing failure.

The use of Tapered Roller Bearings in ALL Wisconsin Engines from the smallest to the largest . . . 3 to 30 hp., single cylinder, 2-cylinder and 4-cylinder . . . is typical of the engineering diligence devoted to providing the user with "Most H.P. Hours of on-the-job service."

Single cyl. 3 to 9 hp.

2-cylinder 7 to13 hp.

V-type 4-cyl. 15-to 30 hp.

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Oil field distributors for Wisconsin Engines and all types of utility units.

Peter B. Kievit, 61, chief auditor of the Eastern division of Tide Water Associated Oil Company, died suddenly from a heart attack on March 17. Kievit, whose headquarters were at the company's New York office, resided at Glen Rock, New Jersey. He joined the company in 1923 as an accountant.

Robert H. Stewart, of Hollis, New York, has joined the headquarters staff of the American Petroleum Institute as administrative assistant to the president. Stewart came to the API from the California Texas Oil Company, Ltd., where he had been assistant to the vice president in charge of marketing. He began his career with Caltex in 1937. He is a New York University night school graduate.

James W. Reid, who has been associated with the legal department Sinclair Oil Corporation for the past 30 years, has retired. Reid received his early education in Kansas and was graduated from Baker University, Baldwin, Kansas, with an AB degree.

He attended the Kansas City School of Law, from which he received his LL.B. and was admitted to the Bar in 1908. In 1920 he entered the legal department of the Sinclair organization.

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FOR speedy, low-cost cleaning of rotary tables, mud hogs, crown blocks, drilling rigs, drilling-rig Diesels, pipe lines, etc., try Oakite Steam-Detergent Cleaning. In fact try it on the toughest cleaning or paint-stripping job that comes along.

By combining the vigorous detergent action of a specialized Oakite material with mechanical force and heat, Oakite Steam-Detergent Cleaning literally blasts dirt away. Grease and muck disappear almost like magic. You'll particularly like the way you can clean hard-to-get-at recessed areas.

Oakite Booklet "How to Cut Cleaning Costs in the Petroleum Industry" contains details. Shows how to speed up and cut costs on other maintenance cleaning jobs with Oakite Steam-Detergent Cleaning. Copy mailed promptly on request. No obligation.

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MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. & Canada

H. A. Grimes, a veteran of 28 years in the oil industry, was appointed a member of the management committee in Venezuela for Creole Petroleum Corporation. Grimes began his career in Venezuela in 1922 as a field engineer with Creole. Since that time almost all of his work has been done in Latin America.

From 1922 until 1943 he was stationed with Creole in Venezuela during which time he rose to the position of manger of the Eastern division of the company.

Sylvester Dayson, president of Premier Oil Refining Company of Texas and general manager of Premier Petroleum Company, has resigned. He will be succeeded by **R. P. Hargis** who has been associated with him over the past 25 years. Dayson will be available on a consulting basis to the Premier organizations as well as its owners.

Hargis, the new president and general manager has been associated with Dayson over a period of years. He has served with him in various companies and in various capacities and is thoroughly grounded and experienced in the management of these companies.

C. H. Todd, Rine Drilling Company, Wichita, Kansas, and a director of American Association of Oilwell Drilling Contractors, was elected chairman of the Kansas Chapter of the Association at a meeting held in Wichita recently. He succeeds **Heber Beardmore, Jr.,** Beardmore Drilling, also a director of AAODC and first chairman of the Kansas chapter.

Other officers elected were: **E. L. McCartney,** B & R Drilling, vice-chairman for the Wichita area; **James G. Adkins,** Adkins Drilling, vice-chairman for Central Kansas; and **B. W. Burks,** Derby Drilling, secretary.

R. C. Cashin, geological engineer and **George H. Fentress,** geologist, for Phillips Petroleum Company at Port Gibson, Mississippi have been transferred in similar capacities to Marshall, Texas.

Donald B. Edwards has been appointed chief engineer, manufacturing department, for Stanolind Oil and Gas Company. He will fill the vacancy left by the resignation of **A. J. Pettigrove,** who had been chief engineer for Stanolind since March, 1948.

Formerly chief gas engineer in the manufacturing department, Edwards has been with Stanolind since November, 1946, when he joined the company as assistant chief gas engineer. Pettigrove had been with the company 4 years at the time of his resignation.

M. Servan G. Cantacuzene, research engineer, will direct the office in Paris, France, of the Southwest Research Institute. Situated at 207 Rue de L'Universite, this is the fourth established by the Texas industrial research laboratories, the others being in San Antonio, Houston, and New York.

In addition to representing Southwest Research Institute, which conducts industrial and agricultural research for companies, associations, and individuals on a cost-fee basis, the

M. Servan G. Cantacuzene

Paris office also handles European matters for Institute of Inventive Research, serving manufacturers and inventors, and the Foundation of Applied Research, conducting fundamental scientific investigations in agriculture and medicine. All three are nonprofit institutions founded by Tom Slick, Texas oil producer and rancher.

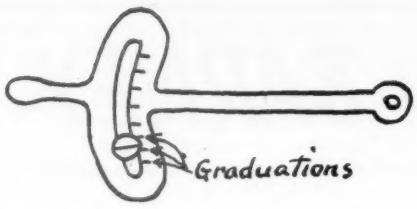
Dr. Harold Vagtborg, president of the Southwest Research Institute, made the announcement of the opening of the Paris office and the appointment of Cantacuzene.

A former research and consulting engineer for French and Rumanian oil companies, Cantacuzene, graduate of the Universities of Bucharest and Paris, has worked with problems in evaporation loss redution, acid sludges, transportation of viscous fuels, breaking of heavy emulsions, corrosion, optics, mechanics, and meteorology. His special fields are research work efficiency, and scientific and technical analysis.

Simple Damper Kink Can Save Valuable Fuel

Fuel is becoming more and more precious, hence the saving of fuel is becoming more and more important and necessary. Here is a simple kink that may prove valuable to you even though the amount of fuel you buy each year is relatively small. An engineer is employing it on his house-heating boiler, and he showed it to this writer.

Most boilers and heaters are provided with damper regulators or dampers of one kind or another and many of these are equipped with a lever device placed in a convenient position for opening and closing the damper. The operator is obliged to go about the process of regulation more or less blindly, however, or by



guess. The position of the handle does not tell the exact amount the damper is open. Therefore the method is not accurate.

This engineer carefully measured the opening of the damper and made graduation marks on the lever as indicated in this sketch—each graduation representing a half-inch or full inch of opening. Now he knows exactly what's what and has made a substantial reduction in the amount of fuel burned under his boilers. It takes only a few minutes to do the graduating and it may prove to be well worth while to do the same thing or equivalent.

—W.F.S.

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LAUGH WITH BARNEY

Before signing a receipt for his pay check, the young man was handed a company form slip with the wording: "Your salary is your personal business—a confidential matter—and not to be disclosed to anybody else."

He read it carefully, then, shielding the paper with his hand, he wrote:

"I won't mention it to anybody. I'm just as much ashamed of it as you are."

* * *

Woman Customer (in bank): I would like to a make a loan."

Bank Official: You'll have to see the loan arranger.

Woman: Who?

Official: The loan arranger. The loan arranger!

Woman: Oh, you mean the one who says, Hi-Ho Silver?

* * *

"Mister, could you spare $100 for a cup of coffee?"

"Since when did a cup of coffee cost $100?"

"I want to get mine in Brazil. I like it fresh."

* * *

"Your girl is spoiled, isn't she?"

"No, it's just the perfume she's wearing."

* * *

An outbreak of smallpox in a southern city caused an order to be issued for the immediate vaccination of all citizens who had not been thus immunized within the year. To facilitate the work, each voting precinct had its own vaccination unit and residents were required to report to it as soon as possible.

A negro mammy applied at the wrong place. "Sorry, Mammy," said the doctor, "you'll have to be vaccinated in your precinct."

"So das it," said Mammy, righteously indignant. "De white ladies gits vasinated in de ahms or de laigs—and we gits it in de precink!"

* * *

The family had overslept and the lady of the house woke with a start to the clanking of cans down the street. She remembered that the garbage had not been put out, and raced down to the front door, struggling into a robe, with her hair in curlers, and looking sleepy-eyed.

"Yoo hoo," she called. "Am I too late for the garbage?"

"No," shouted the collector. "Jump right in."

* * *

Finding her husband in a bar, she sampled the highball he was drinking, and demanded, "How can you drink such horrible stuff?"

"See!" said the husband, "And all the time you thought I was out having fun!"

* * *

There was a little country girl who always went out with city fellers because farm hands were too rough.

* * *

To keep young, associate much with young people. To get old in a hurry, try keeping up with them.

* * *

Customs officer: Lady, you said this bag contained clothes, but it's full of brandy.

Woman: Certainly—my husband's nightcaps.

* * *

During a flood in a little Ohio town a girl was perched on top of a house with a small boy. As they watched various articles floating along they noticed a straw hat on the water. Presently the hat turned and came back, then turned again and went downstream. After it went a certain distance it turned and came back again.

The little girl said, "Do you see that hat? First it goes downstream, then it turns and comes back."

The boy replied, "Oh, that's father. He said, 'Come hell or high water, I'm going to cut the grass today.'"

* * *

He stopped at a small hot-dog stand and ordered coffee. Just to be polite, he said: "Looks like rain, doesn't it?"

"Well," snapped the testy proprietor, "it tastes like coffee, doesn't it?"

* * *

The teacher had talked about always being kind and forgiving. Then she asked, "Now, Jim, couldn't you forgive a boy who had insulted or struck you?"

"Yes, mam—uh - yes, I think - I could. I know I could if he was bigger than I am."

* * *

A colored porter in a hotel was asked why rich men usually gave smaller tips than poor men. "Well, suh," the porter answered, "the rich man don't want nobody t' know he's rich and the po' man don't want nobody to know he's po'."

* * *

"I just got out of prison this morning," a traveler told a man on the train. "It's going to be tough, facing old friends."

"I can sympathize with you," commiserated the other. "I'm just getting home from Congress."

* * *

The right man is said to be waiting for every girl, but the question is, will he still be waiting when she gets there?

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(To be continued)

OIL AND GAS TRADE NEWS

Pipe Mill Plant Opened

The first large diameter welded steel pipe mill operation on a production line basis in the Gulf Coast area has begun production on a limited scale. Kane Boiler Works, Inc., of Galveston, Texas, announced recently that the new installation will soon be producing big-inch line pipe, up to 36-in., OD size, for the market on a full scale production volume.

The new expanded pipe mill is designed to manufacture welded steel pipe in sizes ranging from 12¾-in. outside diameter to 36-in. outside diameter, in 40-ft lengths. Production capacity will exceed 10,000 tons per month when full capacity turnout is under way shortly.

Dravo Buys Pipe Fabricating Plant

Dravo Corporation announced purchase on March 15 of a large pipe fabricating plant at Marietta, Ohio. The facilities were formerly owned by International Derrick and Equipment Company. The property consists of two manufacturing buildings, storage yards and an office, and comprises 93,000 sq ft of floor space. Dravo headquarters are in Pittsburgh.

Operation of the new plant by Dravo's machinery division will follow purchase and installation of equipment for the piping department of the company. Dravo has been supplying fabricated piping for many types of industry.

Kobe Opens New Shop

In expanding its program to provide a more complete field service for a rapidly increasing number of hydraulic pump operators, Kobe, Inc. recently opened a new repair shop at Kilgore, Texas. It was the third such shop to be set up in the past few months. In addition to facilities for servicing hydraulic pumps, the shop has a built-in test well in which every pump is run.

A "shopwarming" attended by oil men from East Texas and neighboring fields was arranged by Carl Brown, district manager. Russell G. Ralph, Kobe Mid-Continent division manager, and Ray Elner, Southern area manager, were on hand for the affair.

Division Managers Meet. A three day conference was held recently by Rockwell Manufacturing Company at the Pittsburgh Athletic Association in Pittsburgh, Pennsylvania. Those attending included: First row—W. S. Potter, A. J. Kerr, L. A. Dixon, Col. W. F. Rockwell, W. F. Rockwell, Jr., Jas. E. Ashman, Pittsburgh; R. P. Melius, power tool division, Milwaukee; C. A. Wiken, Pittsburgh. Second row: Wm. A. Marsteller, East Chicago; W. H. Newbaker, Pittsburgh; W. F. Crawford, Edward Valves, East Chicago; H. C. Stuckeman, Delta Manufacturing, Milwaukee; R. C. DuBrucq, Crescent Machine, Leetonia, Ohio; E. W. Meyers of M. J. Carl, Pittsburgh. Third row: L. A. Dixon, Jr., Pittsburgh DuBois, Dubois, Pennsylvania, H. F. Zorn, V & O Press, Hudson; A. R. Whittaker, National Meter, Brooklyn, New York; R. G. Caouette, Pittsburgh; H. S. Rockwell, Hopewell, Hopewell, New Jersey; W. H. Marsh, Hydraulics, Pittsburgh; A. Kroeger, A & H Kroeger Organization, New York City; W. R. Brown, Arcade Manufacturing, Freeport, Illinois. Fourth row: E. F. Foubert, Pittsburgh; L. W. Heavner, Macnick, Tulsa; W. T. Kiehl, Jr., Pittsburgh; F. V. Snodgrass, Nordstrom Valve, Oakland; E. W. Haas, Ohmer Corporation, Dayton, Ohio; A. P. Schmauch, and C. S. Bygate, Pittsburg.

Dillon Repurchases Stock

S. V. Dillon has announced the repurchase of the stock of Dillon Coupling, from the Climax Division of General Finance Corporation. Dillon, president of the company, sold his interests to Climax during the war. The company manufactured the Dillon coupling, which has been on the market the past few years under the name Climax lock coupling.

It is a grooved-type coupling with a two-part housing bolted together with a synthetic multiseal gasket insert that fits over the ends of the pipe and permits normal expansion and angular deflection of the line.

GM Diesel Salesmen Awarded

Ten retail salesmen for General Motors Corporation, Detroit Diesel division, have been honored for their outstanding achievements in the sale of diesel engines in 1949. They have been awarded diamond rings and certificates of merit under a plan sponsored by W. T. (Bill) Crowe, general manager of the company.

One man was chosen from each of the 10 domestic zones to receive the diamond award. They were:

Charles R. McDonald, Walter H. Moreton Corporation; Andrew W. Winnberg, Frantz Equipment; Lee Hardiman, Florida Diesel Engine Sales; Samuel P. Vinson, Lewis Diesel Engine Company; David H. Geary, Western Machinery and Engine; J. A. Dunham, Diesel Equipment Company, Inc.; N. N. Elkins, Stewart and Stevenson Services, Inc.; S. T. Collins, Jr., Olson Manufacturing; Gilmore R. Salyers, Anderson-O'Brien, and Bradley Bartlett, Evans Engine and Equipment.

S & J Opens Tulsa Branch

Shand and Jurs Company of Berkeley, California, manufacturers of petroleum refining, transportation, and storage equipment fittings, have recently announced the opening of their new factory branch office in Tulsa, Oklahoma. This move is another step in the program to bring S&J's engineering and supply services into closer contact with each geographical area of petroleum industry operations, it was stated. It was also announced that Breen Ringland has been appointed division manager of the Tulsa office.

Ringland joined S&J's sales organization in January, 1946, following extensive experience in the oil industry, which included several years as inspector of petroleum storage tanks and storage tank fittings.

Bethlehem Completes New Supply Store

Bethlehem Supply Company announces the completion of a new oil field supply store at Great Bend, Kansas. The new Great Bend store, which is currently doing business, carries a very complete stock of oil field drilling and production equipment required to meet the needs of the oil industry in this vicinity.

W. B. Page will continue as store manager and field representative in the new store. L. R. Cousland will remain, also, as assistant store manager. Field representatives, H. B. Anderson and R. C. Neugent, will make local and field sales contacts throughout the store area. C. W. Young, special representative at Garden City for sales coverage in the oil and gas fields in that area, is also from Great Bend.

Rolo To Handle Sales for Progressive Engineering

The Oklahoma and Kansas territories of the Rolo Manufacturing Company are now being handled by the Progressive Engineering Company of Tulsa, Oklahoma, Rolo officials have announced.

Progressive Engineering, which was organized in 1949 to serve this area, is now prepared to sell and service all of the Rolo products—including well checkers, separators, and water knockout equipment. Ernest L. Graves and William H. Mason, are owners of the Tulsa concern.

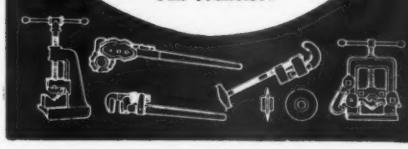
CHAIN TONGS

"ARMSTRONG BROS." Chain Tongs come in "Standard," "Reversible Jaw" and "Ideal" (V-jaw) types—in sizes for every need. Their drop-forged jaws have milled teeth, are hardened, tempered and tested for wearing qualities. They have heavy forged-in lugs that give extra bearing on the handles to which they are rigidly held by a large hardened steel bolt. The handles are forged and heat treated to the correct balance of stiffness and spring. Shackles are drop forged and chains proof-tested to ⅔ catalog strength (3,600 lbs. to 40,000 lbs.).

Stocked by Leading Tool Departments

Write for Catalog.

ARMSTRONG BROS. TOOL CO.
5231 West Armstrong Avenue
Chicago 30, U.S.A.
New York
San Francisco



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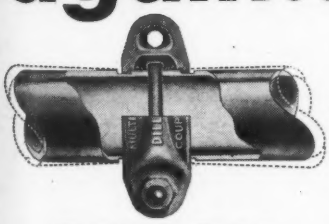


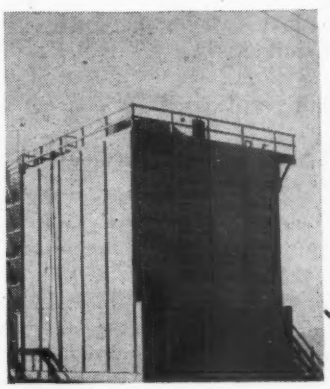
DILLON
flexible-locked
COUPLINGS

A grooved-type coupling with a two-part self-aligning housing. Synthetic Multi-seal gasket gives great flexibility without leakage —pressure or vacuum. Available in sizes from 2" to 20".

Hold that line with Dillon Couplings

THE DILLON CO.
TULSA 5, OKLAHOMA

"Our best ads are installed . . ."



Two cell induced draft cooling tower.

COOLING TOWERS
WOOD TANKS
STAINLESS TANKS
WOOD PIPE
MULTI-FIN UNITS

since 1903

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TANK & TOWER CO.
ENGINEERS • FABRICATORS • ERECTORS
5401 S. Boyle Ave., Los Angeles 11
Branches: New York, Boston, Chicago, Tulsa, Houston, San Francisco

Rollans-Elliott Is Named Representative

Rollans-Elliott Company has been appointed representative in West

Gene Hollis

Dean Rollans

Texas and New Mexico for Ben F. Kelley Company, Inc., manufacturers of spinning line and breakout catheads, power slips, and other KelCo safety products. Gene Hollis, former district manager for Jarecki, will be in charge of the Odessa office and warehouse. Rollans-Elliott will maintain complete stocks of KelCo products and parts. The new distributor and Kelley both have headquarters in Tulsa.

Cooper Sponsors Valve Clinic

The Cooper Alloy Foundry Company, Hillside, New Jersey, has announced the scheduling of the second in the proposed series of stainless steel valve clinics. Planned for April 26, the clinic will be in the form of a dinner-meeting at the Statler Hotel in Buffalo, New York.

Program for the evening includes a discussion of stainless steel valve types . . . their application, design features, and maintenance factors; and a detailed discussion of various corrosion resistant materials utilized in stainless valve manufacture. A round table discussion will follow the presentation. Admittance will be by invitation.

Core Lab Made Distributor

Core Laboratories, Inc., Dallas, Texas, has been appointed exclusive distributor for OB Mud Guns domestically East of California and Canada. Manufactured by Oil Base, Inc., Compton, California, these guns are available in three models, for top-hole and bottom-hole mixing. Distribution in California will be handled from present Oil Base, Inc., warehouses in Compton, Ventura, and Bakersfield.

Bechtel Opens Tulsa Offices

Bechtel Corporation, engineering and construction organization of San Francisco, California, opened offices in the Philtower Building, Tulsa, Oklahoma, recently.

George Gibson, formerly the firm's New York representative, will be manager at Tulsa. Bechtel Corporation is heavily engaged in power development, and the construction of factory and industrial buildings for the food, soap, glass, copper, and steel industries.

Pipe Sales To Continue Believes National Supply

Although supply of foreign and domestic oil in excess of present demand has had an adverse effect on oil-field equipment and supply sales, general pipe sales should continue at present high levels through the summer of 1950, according to A. E. Walker, president of The National Supply Company, Pittsburgh, Pennsylvania. Walker's observations and predictions are contained in the company's annual report for 1949.

In citing the leveling off of domestic oil field activity, Walker pointed out that the general price level for most crude oils has remained stable, although "a sharp restriction on production in a number of states, particularly in Texas, has reduced the income of the U. S. oil producer." Feature of the report is a table giving comparative operating and financial data for the past 10 years.

Rector Well Erects New Office Building

Construction is under way on a one-story office building for Rector Well Equipment Company, Inc., Fort Worth, Texas, manufacturers of well head equipment, cementing equipment, and thread sealing compound. The new office building is being erected at N. E. 10th and Commerce Streets, across the street from the company's plant.

Laurence L. Rector, president of the company, says the new building is expected to be finished about May 1. It has 4000 sq ft of floor space and will house the company's general offices, drafting room, accounting department, and sales offices.

Rector Well's new office building in Fort Worth.

THE RIGHT ALLOY
is the Right Answer to Many Piping Problems

Until recently, piping engineers were limited in their choice of piping materials to carbon steels, a few low alloy steels, wrought iron, cast iron and brass.

Today, thanks to metallurgical research and new welding techniques —many more materials are available, including intermediate and high alloy steels containing chromium, nickel, or both . . . commercially pure nickel . . . copper . . . aluminum . . . and alloys in which nickel, copper or aluminum is the major constituent.

Rapid corrosion of piping by the fluid handled, or contamination of the fluid by corrosion of the pipe—or by catalytic action of the pipe material with the fluid, are problems which today's piping engineer faces. Often, these problems are complicated by pressures and temperatures at which the fluid must be conveyed, or by wide fluctuations of pressures and temperatures when the process is cyclic in nature.

Each of these service conditions demands utmost care in the selection of the piping material.

Tube Turns, Inc. is constantly studying all of the factors involved in the application of alloy materials to piping systems. Today the ever-expanding line of Tube-Turn Welding Fittings includes more than 40 different alloys in both ferrous and non-ferrous classes . . . to help solve *your* piping problems.

FREE BULLETIN

Write today for your free copy of "Special Alloys", a bulletin containing valuable information of Stainless Steels, Nickel and Nickel Base Alloys, Copper and Copper Base Alloys, and Aluminum and Aluminum Base Alloys. Discusses physical characteristics, service conditions and gives chart of sizes and wall thicknesses available

"Be Sure You See The Double tt"

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

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Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY DISTRIBUTORS IN ALL PRINCIPAL CITIES

DISTRICT OFFICES: NEW YORK • PHILADELPHIA • PITTSBURGH • CHICAGO • HOUSTON • TULSA • SAN FRANCISCO • LOS ANGELES

Nelson Appoints Randolph As Sales Representative

Nelson Electric Mfg. Company, Tulsa, Oklahoma has appointed H. J. Randolph Company as its sales and service representative in the Los Angeles area.

H. J. Randolph has long been associated with the oil industry in electrical engineering and field sales work, and is well known for his active participation in AIEE affairs.

An engineering graduate from Iowa State College, he spent seven years with Westinghouse Electric Corporation, followed by several years of field work with other manufacturers.

Mack Opens Diesel Training Courses

Free training courses on diesel-powered trucks and buses are being offered by the Mack Truck Company. Eligible for enrollment in these free diesel courses are truck owners, maintenance superintendents, shop foremen, garage or service station mechanics, and persons employed in any capacity allied to the maintenance or operation of trucks and buses.

Dates have already been announced for openings at Southern and Midwestern points and schedules are being arranged for a steady progression of courses from coast to coast.

Robinson Will Head New Franklin District Office

The opening of a new Franklin Supply Company district office in Houston has been announced by Larry Harper, vice president, Tulsa, Oklahoma. E. W. "Bud" Robinson, former assistant sales manager for WKM Company in Houston, has been appointed district manager.

E. W. Robinson

Offices are in the Esperson Building. Office manager is Bill Carroll from Franklin's Grayville, Illinois, branch. Other Franklin offices and stores are in Chicago, Illinois, Mt. Pleasant, Michigan, and East Chicago, Indiana.

Allis-Chalmers Extends Magic-Grip Sheave Line

Extension of its Magic-Grip sheave line to include A-B combination groove sheaves in sizes from 3 to 38 in.—one to six grooves—in both collar and no collar types has been announced by Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

Both the collar (Style C) and non-collar (Style NC) types operate on the same principle of clamping the sheave quickly and firmly to the shaft by compressing the split tapered bushing sleeve. The Magic-Grip non-collar bushing is a new development. It has radially adjusted setscrews and is especially designed to allow maximum bores in the smaller pitch diameters, and can be mounted and demounted as quickly as the collar bushing.

Southern Acquires Whitaker

Southern Contracting Company has acquired the O. C. Whitaker Company. Southern has announced that it will continue in the pipe line construction business with the same management-equipment and field organizations. The company will have the same address, 804 Dan Waggoner Building, Fort Worth, Texas.

Robert Thomas is president of the organization, I. C. Little, Sr., vice president; J. C. Briscoe, vice president and secretary-treasurer, and J. C. Minyard, general superintendent.

T hree sizes for shallow, medium, and deepest wells

H and lever assures simple operation

O perates perfectly at maximum flow or idling

M ore profits - low cost to buy - no cost to operate

P rovides accurate foot by foot cuttings

S ample machine *Provides Accurate Samples*

O nly clean mud goes back into machines

N o abrasives to wear out equipment

The screen drum is rotated by the precision power wheel which is turned by the mud flow discharge from the pumps. Built-in water-spray screen cleaning system may be supplemented by Electric Mud-Spray Screen Cleaning Attachment shown on model at immediate left and close-up at far left. The Electric Attachment is available separately for conversion of your Thompson machine.

THOMPSON TOOL CO.

P. O. BOX 357 PHONE 3521

IOWA PARK, TEXAS

TRADE PERSONALS

M. Russell Kambach has been named advertising manager for Aluminum Company of America. Kambach, who has been assistant advertising manager since 1949, will be succeeded in that position by **Jay N. Sharp** of the ALCOA advertising department.

A graduate of Carnegie Institute of Technology, Kambach joined ALCOA's advertising department in that year. Sharp was graduated from Western Reserve University in 1929. He joined ALCOA in 1943.

James G. DeFlon, engineer with Fluor since 1941, has been assigned duties in Fluor's New York sales office. This is following his return upon completing details of the company's agreement with Head Wrightson Processes Ltd., in London, England.

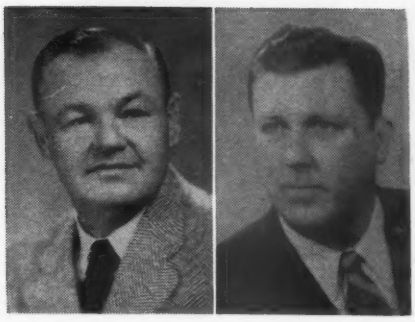
Lee Weidlien, engineer for Fluor in the Los Angeles sales office from 1943 to 1948, recently rejoined the company to take charge of sales in Fluor's San Francisco office. He is a graduate of the University of Kansas.

Jack E. McKay, advertising manager for Fluor in Los Angeles, was advanced to the position of sales engineer in Fluor's Houston sales office. A graduate of the University of Oklahoma, McKay joined Fluor in 1942.

Orville W. Barnett was appointed gas products sales supervisor in the Tulsa, Oklahoma district for Rockwell Manufacturing Company.

Barnett was employed by Rockwell following his graduation from Oklahoma University in 1934, where he majored in engineering. He will continue to maintain his headquarters in Dallas, and his new duties call for him to assist the general sales force in gas product sales and service products.

Jay C. Failing has been named agent for Mexico for the George E. Failing Supply Company, manufacturers of portable exploration and water well drilling equipment, of Enid, Oklahoma. For the past few years, Failing has been serving as West Coast representative for the Failing Company. He will continue to handle this territory in addition to his new Mexican assignment.

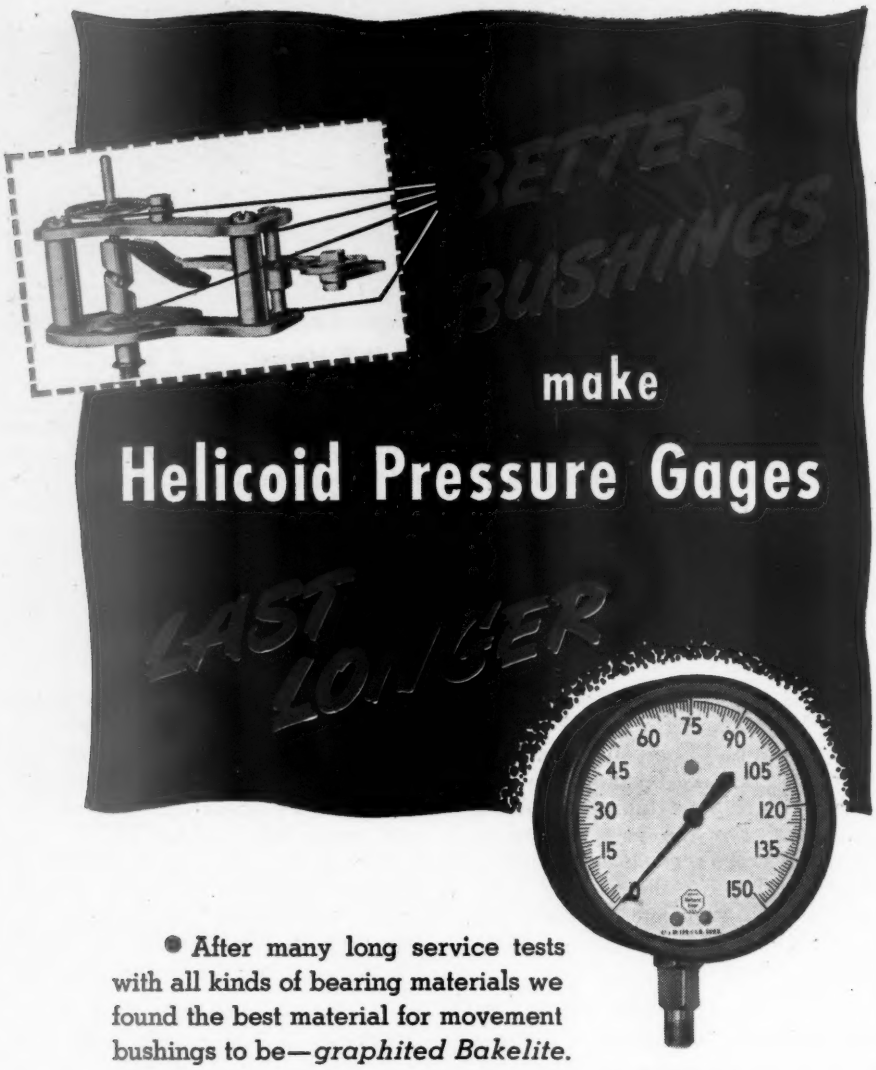


H. F. Harper R. B. McCullar

H. F. (Tex) Harper has been appointed by Welex Jet Services, Inc. as sales manager for the South Texas area. Harper has been with Welex since January 1, and was formerly with Baker Oil Tools, Inc. as district manager of the Corpus Christi area. He had been with Baker since 1937. His headquarters are in Corpus Christi, Texas.

Roland B. (Luke) McCullar has been appointed Welex sales manager for the Louisiana-Arkansas-East Texas area. McCullar has been with Welex since January 1. Formerly he was employed by Lane-Wells Company, and had been district manager at different times in the Mid-Continent area, North Texas, the Rocky Mountain area, and in Illinois. McCullar's headquarters will be in Shreveport.

Daniel Sales Staff Conference. The Daniel Orifice Fitting Company, pioneer manufacturers of Orifice meter measuring equipment, recently held a four-day meeting in Los Angeles of the sales and engineering staff, pictured below. Left to right—Jack Derr, Los Angeles; J. G. Holdenreid, Los Angeles; F. N. (Newt) Davis, Tulsa; Paul S. Pirkle, Houston; S. Walter Beal, Odessa; Ralph H. Clemons, Los Angeles; Carl Davis, Davis & Davis, Denver; P. M. Vickery, Fort Worth; W. A. Stoeltzing, W. A. Stoeltzing Company, Pittsburgh; L. Waldo Wilbern, Los Angeles; A. E. Ehrke, A. E. Ehrke and Company, Cleveland; A. Ring, Los Angeles; J. Virgil Moore, Houston; Carroll O. Cox, Houston; Fred Crabbe, Malcolm W. Black and Company, Inc., New York; Joe E. Strader, John Whalen, George Frerichs, and Charles Willrich, all of Los Angeles; Glenn W. Daniel, Houston; W. A. Griffin, Jr., Houston, and Paul P. Daniel, Los Angeles.

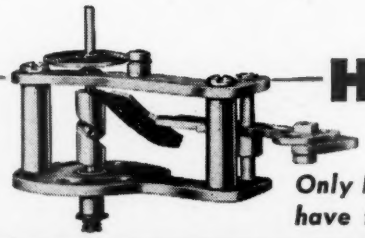


● After many long service tests with all kinds of bearing materials we found the best material for movement bushings to be—*graphited Bakelite.*

Graphited Bakelite bushings outwore all others—ran 50,000,000 full stroke cycles at 700 cycles a minute with negligible wear, no corrosion, no distortion from impact.

Among other tests, one of the largest public utilities found that HELICOID GAGES with these bushings lasted four times longer than any other gage tested under the same severe conditions.

Helicoid movements with graphited Bakelite bushings have less static and kinetic friction. They are now standard in all Helicoid gages—at no extra cost.



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

J. W. Elizardi

Richard Aubrey

▸ **James W. Elizardi** has recently been made manager of the Houston sales office of The Marley Company, Inc. Elizardi, who is a graduate of Tulane University, previously worked for Griscom-Russell and the Illinois Central Railroad.

▸ **Richard Aubrey** has been appointed assistant to F. M. Rich, Kaiser Steel vice president in charge of operations, as liaison man on tubular steel products.

In this capacity Aubrey will stimulate sales and help solve customers' pipe line problems as part of Kaiser Steel's expanding entry into production of big pipe for the pipeline and petroleum industries. Aubrey, who holds several patents on tubular testing procedures, has been with Youngstown Sheet and Tube for 26 years, the last 10 in research.

▸ **Richard Morton,** Warner Lewis Company, Tulsa, Oklahoma, was recently appointed New York representative.

Morton is a registered chemical engineer, and has had many years' experience with refiners and refining engineering firms. He will handle the sales and engineering phases of Excel-So products.

▸ **A. F. Fenner,** vice president of Mack-International Motor Truck Corporation, has been named general sales manager, with headquarters in Chicago, Illinois. He will direct all of the company's truck, bus, and fire apparatus sales and service activities in its Central, Southwestern, and Pacific Coast divisions.

Fenner joined the Mack organization in 1915 as sales manager in its Albany (New York) branch. In 1929 he was named manager of Mack's central division in Chicago, a position he relinquishes to assume his new duties.

▸ **Pelton W. Ellis** was named manager of the refining equipment division of Peabody Engineering Corporation, New York, N. Y. Previous to his employment with Peabody Engineering, he spent several years as a sales engineer in the petroleum industry in South America.

D. C. "Bert" Royce was named manager of the new Buckeye factory service parts station at Tulsa, Oklahoma for Gar Wood Industries, Inc. He was formerly with the Buckeye Traction Ditcher Company now Gar Wood Industries, Inc., Findlay division, and has 39 years of experience in ditching equipment.

R. D. "Bob" Snoddy is the new parts manager for the new factory service parts station.

F. S. Jones was elected vice president in charge of sales for The Colorado Fuel and Iron Corporation. He will succeed **Newell H. Orr** who has retired but who will continue in an advisory capacity. Jones came with CF&I in 1908. He began selling in Hutchinson, Kansas, as a combination fuel and steel salesman in 1913. Since then he has held managerial positions in most of the company's territory.

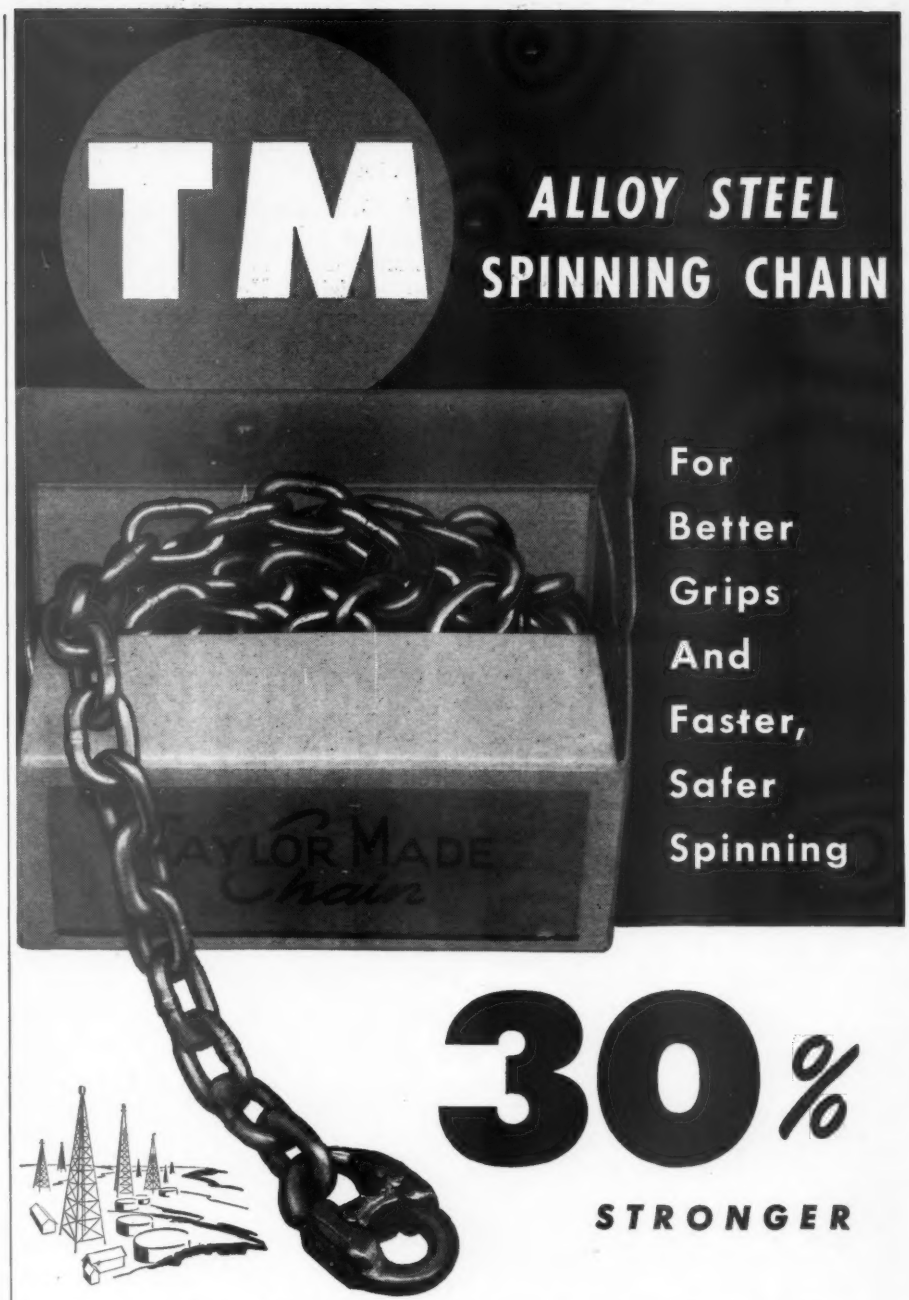
The position previously occupied by Jones, that of general manager of commercial steel sales of the Western division, will be filled by **James N. Counter,** advancing from Rocky Mountain division sales manager. A native of Denver, Counter has filled several district managerships during his services with CF&I.

Carl Joys, Jr., who was connected with the A. O. Smith Corporation for many years as a sales executive, has rejoined the firm as an assistant to the president. Joys has long been associated with the petroleum and oil refinery industries, and his new duties with A. O. Smith will center primarily in this field. He originally joined A. O. Smith in 1924.

Gerald C. Rasey was named sales manager of the engine division, Enterprise Engine and Foundry Company. A native of Beloit, Wisconsin, Rasey began as an apprentice engineer in 1918 while attending college, and in the intervening years has been continuously identified with the diesel engine field in both engineering and sales.

Pierce J. Fleming has been appointed manager of Mack-International Motor Truck Corporation off-highway sales division. A pioneer in the truck sales field, Fleming joined Mack in 1918 and had served either as salesman or branch manager in Minneapolis, Buffalo, and Cincinnati before becoming branch manager at St. Paul in 1938.

Also announced is the appointment of **John Walker** as manager of Mack's off-highway sales engineering division. Walker also joined Mack in 1918 and has served in various capacities in the engineering, sales engineering, and off-highway divisions.



The New TM Alloy Spinning Chain meets the drilling requirements of today's deeper holes and hardened joints. *It's 30% stronger,* it's tougher and much harder than conventional Hi-Test Spinning Chain. Complete heat treatment in modern furnaces means uniformity in every link. Shorter links assure better grips. (TM Alloy links are .80 inch long inside compared to .92 inch inside length of regular spinning chain.) For longer life and faster, safer spinning, *insist on* TM Alloy Steel Spinning Chain. See your nearest supply store for further details on this amazing new spinning chain development.

S. G. TAYLOR CHAIN COMPANY, HAMMOND, INDIANA

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

E. T. Adams has been appointed district manager of oil country valve sales in the Houston sales territory by Kerotest Manufacturing Company. Adams had been director of purchases and head of production control at the home offices in Pittsburgh, Pennsylvania. He joined Kerotest in 1945 as a steel valve salesman in the Houston territory.

S. A. Clarke, Jr. has been named the new Kerotest purchasing agent.

Carl G. Naylor, founder and president of the Naylor Pipe Company, Chicago, passed away suddenly on February 13, at the age of 70. Burial was in Mason City, Illinois.

F. W. Gaushell has been appointed manager of the Continental Supply Company's store in Alice, Texas.

O. A. Kent was also appointed store manager in El Dorado, Kansas. He was formerly a field salesman at that location.

A. G. Hendrickson was appointed assistant sales manager of the Harnischfeger Corporation's, P&H welding division. Hendrickson has had many years experience with P&H, serving for five years as welding engineer in the Milwaukee, Wisconsin and the Minneapolis, Minnesota territories. He was also farm bureau consultant on welding for a year and a half.

Phil Norton

G. D. Butler

Phil Norton, general sales manager of Wisconsin Motor Corporation, Milwaukee, Wisconsin, has been appointed a vice president of the company. He has been connected with the company in a sales capacity for more than twenty years, occupying the executive position of general sales manager for the past 10 years. Recently another signal honor was conferred upon Norton through his election to the post of president of the Internal Combustion Engine Institute.

George D. Butler has been added to the National Technical Laboratories' New York office. As a physicist in instrumentation research at the Calco chemical division of American Cyanamid Company, Butler has had considerable experience, both in the development and use of pH meters, spectrophotometers, and related scientific instruments. Butler also was an engineer for Carl L. Norden Company during the war, and previously was with Bendix Aviation as a Technical Representative.

Karl Ola Lellky, assistant director of public relations of Baroid sales division, National Lead Company, died in Houston March 6. Lellky was born in Boras, Sweden, October 14, 1905 and had been with Baroid since January 1, 1948.

William G. James, formerly Gulf Coast division manager for the Eastman Oil Well Survey Company at Houston, Texas, has been named vice president in charge of sales for the company. James has moved to the general office in Denver, Colorado, where he will direct the company sales division in the Rocky Mountain-Mid-Continent, Gulf Coast, and California areas. James celebrates his 17th anniversary with the company this year.

Replacing James as division manager at Houston is **William D. Compton,** formerly general field engineer for the company with headquarters at Denver. He has been associated with the Eastman company since 1943, when he started as an assistant junior engineer.

If CORROSION IS YOUR PROBLEM

Solve It With CARLON Plastic Pipe

JUST OFF THE PRESS!

We will gladly forward you a copy of "How To Control Corrosion with Carlon ," upon request. No obligation, of course.

CARLON

CARLON is practical for—

- GAS LINES
- LEAD LINES
- SIPHON LINES
- WATER LINES
- GATHERING LINES
- DISPOSAL TUBING

IF you have a corrosion problem on gas lines, gathering lines, lead lines, disposal tubing or other installations, consider CARLON PLASTIC PIPE.

CARLON is an all-plastic pipe that resists corrosion from gases, liquids, and soils, both internally and externally. It's light weight makes it easy and economical to handle and lay.

GREEN CONTRACTING AND ENGINEERING CO., INC.

103 SOUTH VINE . . . WICHITA, KANSAS

CARTER PRODUCTS CORPORATION, CLEVELAND, OHIO, MFRS.

John M. Mitchell has been appointed manager of Aluminum Company of America's export division, and **G. B. D. Peterson** has been named head of the division's New York office.

Mitchell attended the University of Tennessee and began work with the company at its Alcoa, Tennessee plant in 1929. Peterson attended Pennsylvania State College and joined Alcoa in 1928. He has served in various capacities in the sales department since that time.

J. Shannon Baker was recently appointed division operating engineer for the Pacific Coast Division of Lane-Wells Company. **W. J. "Doug" Taylor** succeeds Baker as district superintendent in Bakersfield, California.

J. S. Baker W. J. Taylor

Taylor was formerly assistant superintendent in this district.

Baker has been with Lane-Wells since 1938. Prior to joining Lane-Wells he was employed by the Rieber Geophysical Laboratory. Baker holds an AB degree in physics from the University of California at Los Angeles. Taylor started with the company as perforating rigman in 1941. He advanced to perforating operator and then to electrolog operator. Taylor was formerly with the R. C. Water's Geophysical Company.

John L. Leisenring, Rockwell Manufacturing Company, was named sales engineer for the southern two-thirds of Indiana and several counties in the extreme southern part of Illinois. Leisenring is a native of Pennsylvania and was educated in the Wilkes-Barre and Kingston public schools. He later attended the Dean School of Business at Wyoming Seminary in Kingston, Pennsylvania.

Leisenring, who began with the company in 1945, will be handling the company's line of valves, gas meters, and regulators.

At the annual meeting of the stockholders of Manning, Maxwell & Moore, Inc., held in New York, February 23, the following directors were elected: **James S. Alexander, Colby M. Chester, Colby M. Chester 3d,** elected chairman, **Eugene M. Geddes, J. Robert Kelly, Charles W. Littlefield, Henry M. Luscomb, Hamilton Merrill, John E. Minty, Charles A. Moore 3d, Eugene M. Moore, Henry S. Moore,** and **Robert R. Wason** was re-elected president.

The board of directors also elected Chester as treasurer, and **Miss E. Von Maur** as secretary and assistant treasurer. The following vice presidents also were re-elected: **Henry M. Luscomb, J. Robert Kelley, C. H. Butterfield, Bradford Ellsworth, W. J. Jarrett, Hamilton Merrill,** and **John E. Minty. William J. Jarrett,** vice president and controller retired from active service with the company, and will be succeeded by **John A. Flynn** as acting controller. Flynn has been with the company 34 years.

Harry A. Dennis has been named manager of sales for Graver Tank and Manufacturing Company, Inc's., stainless and alloy steels division. He will also continue his present assignment as manager of Weldment sales. Prior to his association with Graver, Dennis was assistant district manager of sales for Lukens Steel Company.

James A. Durham, storeman in the Charleston, West Virginia, store of Oil Well Supply Company, U. S. Steel subsidiary, has been promoted to store manager. He succeeds **C. E. Lewis,** who was transferred to Odessa, Texas as a field representative.

Durham was connected with "Oilwell's" Parkersburg, West Virginia, store before moving to Charleston.

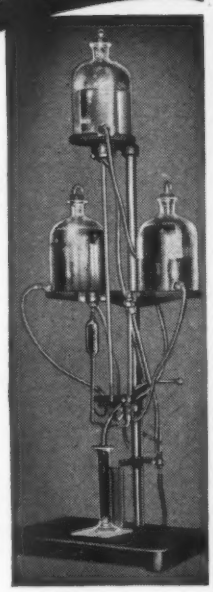
Jack Harris has been appointed sales manager of the Cameron Iron Works' newly created "LP" valve division. For the past several years he has been a member of the Cameron engineering and sales departments, coming

Jack Harris Ames Bliss

to Cameron from the J. S. Abercrombie-Harrison Oil Company refinery at Sweeney, Texas.

Ames Bliss was named sales engineer for the "LP" valve division. Bliss, a graduate of Massachusetts Institute of Technology, was a member of the Cameron engineering staff and has done development work on the new Cameron Lift-Plug valve.

SULFUR and CARBON *Analyses* in PETROLEUM PRODUCTS



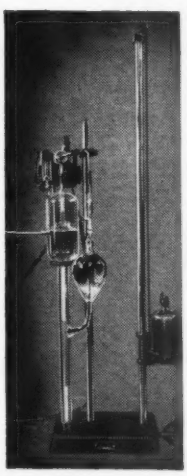
The sulfur content of oils, waxes and greases is an important measure of the value and quality of the product.

Whether the desired sulfur content be high or low, it is necessary to know exactly what amount is present.

The combustion method offers a rapid and sure means of determining sulfur in the wide range of percentages and materials encountered in the oil and grease field.

The Dietert-Detroit Sulfur Determinator embodies the correct principles of the combustion method in a simple, rugged and convenient form. Complete analysis can be made in less than five minutes.

Carbon determinations on organic compounds are being made in as little as two minutes with the Dietert-Detroit No. 3003 Carbon Determinator.



This method can be applied to any petroleum product. One example of the usefulness of this method is the analysis of cracking catalyst for carbon content.

Leading oil companies* are taking advantage of these versatile, time-saving determinators. Write to Dept. P-1 for detailed information on how you can apply rapid carbon and sulfur analysis to your problems.

*Two typical users— { THE SHELL OIL COMPANY / THE PURE OIL COMPANY }

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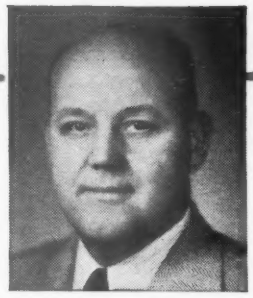
he BS&B Team!

JIMMY DVORACEK
Sales Manager



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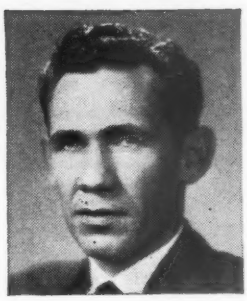
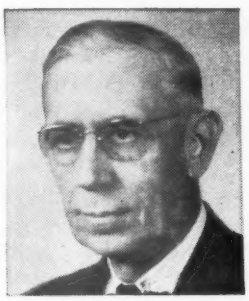
Asst. Sales Manager

R. G. THOMPSON
LPG Sales Manager

PAUL BOWLES
Tulsa



TOM CASEY
Tulsa



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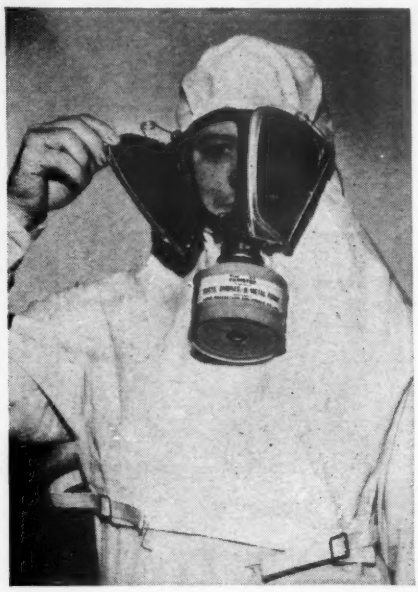
(5) Gas Mask

To protect welders on jobs where there are hazardous gases or smokes, Acme Protection Equipment Company, Chicago, Illinois, has developed a special full vision gas mask, to be known as Pur-a-weld, that can be used interchangeably with dust and fume canister or a compressed-air supply unit.



Advantages of this new type equipment, it is stated, include greater vision in welding helmets; lenses in shades from 4 to 12; complete gas mask protection to reduce headaches, fatigue, and other health hazards; easy fit and comfort; free-breathing; replaceable welding hood; interchangeable air supply to meet different conditions. The complete outfit is furnished in a compact carrying case.

Complete information can be obtained from Acme Company, 3037 West Lake Street, Chicago.

(6) Drill Collars

A new type of drill collar with replaceable ends, designed to minimize the problem of joint failures, is announced by The National Supply Company, Spang-Chalfant Division, P.O. Box 298, Pittsburgh 30, Pennsylvania. Service records have been obtained for the new collars in eight different wells drilling a total of 32,000 ft.

The Ideal replaceable end drill collar has wear subs more or less permanently affixed at both ends. The new drill collar assembly consists of a double-box collar body equipped with a box and pin sub on the upper end and a double pin sub on the lower end. If a collar is used continuously at the bottom of the string both ends have box and pin subs and the bit shank can be connected directly to the

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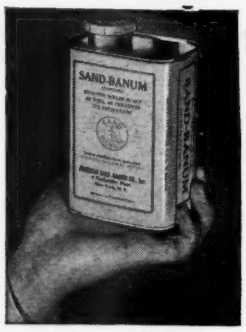

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lower end. The sub can be lengthened enough to be counter-bored for a float valve recess, if necessary.

Available size and style range includes 2⅜ in. to 6⅝ in. regular, 2⅜ in. to 5½ in. IF, and 3½ in. to 6⅝ in. FH.

(7) Transmitter-Receiver

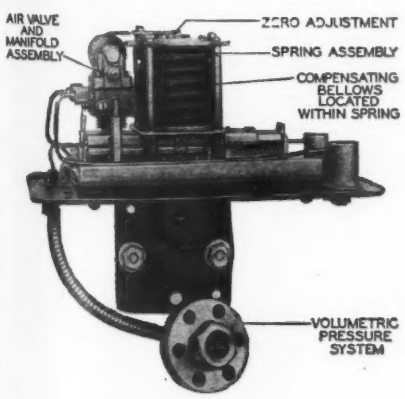
Carfone Station Unit "15", a new portable transmitter-receiver for use as headquarters station equipment in mobile communications systems operating in the 152-174-megacycle range, has been developed by the RCA engineering products department.

The new FM station equipment was designed by RCA to meet the needs of police and fire department systems in small or medium-sized municipalities, taxicab companies, delivery truck fleets, and mobile systems of large industrial plants. The unit is 44 lb.

The Carfone Station "15" is housed in a single all-metal cabinet about 20 in. long, 11 in. high, and 9 in. deep, with all controls on the front panel. The panel and the antenna connection are recessed in the housing for protection during transit. The new FM transmitter has a power output of 15 watts and operates on 115 volts, 60 cycles, a-c.

(8) Pressure Transmitter

A new force-balance type of pressure transmitter called the Transaire pressure transmitter has just been an-



nounced by Taylor Instrument Companies, 95 Ames Street, Rochester, New York. This instrument was developed as a companion to the Taylor Transaire temperature transmitter to offer accuracy of suppressed ranges at high pressure levels.

The Transaire pressure transmitter makes it possible to measure and transmit up to 1000 ft the smallest of pressure changes with an accuracy of ½ per cent of the range span.

Further information may be obtained by writing Taylor Instrument.

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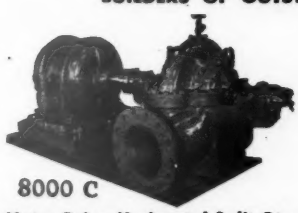
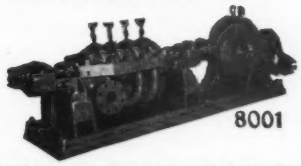


8000 C

Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

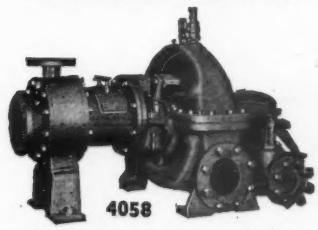


8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

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Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

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(9) Flame Failure Control

The Combustion Control Corporation, 77 Broadway, Cambridge 42, Massachusetts, has announced a new control described as a flame failure safeguard for light-oil burners. Fireye System FF-1 has been introduced to provide flame failure protection for commercial gun type light-oil burners. In the event of light off failure, lock-out will occur five seconds after power has been applied to burner motor.

The manufacturer claims that if flame failure occurs during an operating cycle, safety lock-out will occur within two to four seconds with its System FF-1, as compared with a delay of as much as two minutes with conventional safety controls.

(10) Pump Valves

The Stewart Manufacturing Company of Stamford, Connecticut, announces its new Twin-Seat valve to replace the ball and seat in subsurface oilwell pumps. The twin-seat valve eliminates flutter and pump slippage, producing more fluid per stroke, the manufacturer claims. Its two seats double the resistance to corrosive liquids and abrasive sands. The Stewart twin-seat valve seats steel-to-steel and is backed up with a rubber-to-steel seal-off.

(11) LP-Gas Valves

A new line of globe, angle, and check valves for liquefied petroleum gas service has been announced by Crane Company, 836 S Michigan Avenue, Chicago, Illinois. The new valves have been tested and approved by Underwriters Laboratories, Inc. for use on LP-gas up to a maximum of 250 psi. All three types have screwed ends and are available in sizes ¼ to 2.-in. inclusive.

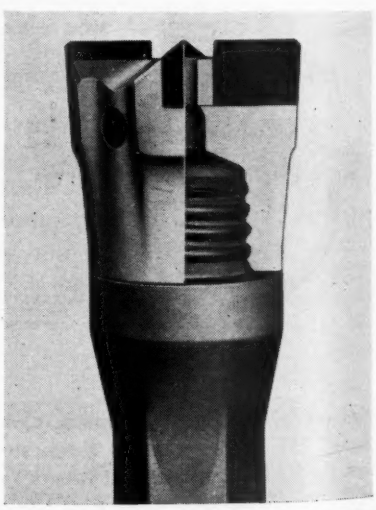
To assure tight seating, the valves have a Crane No. 6 composition disc, which is cemented into the disc holder. Tightness at the stuffing box is provided by one-piece molded asbestos packing in a stuffing box of very liberal dimensions.

(12) Alloy Bit

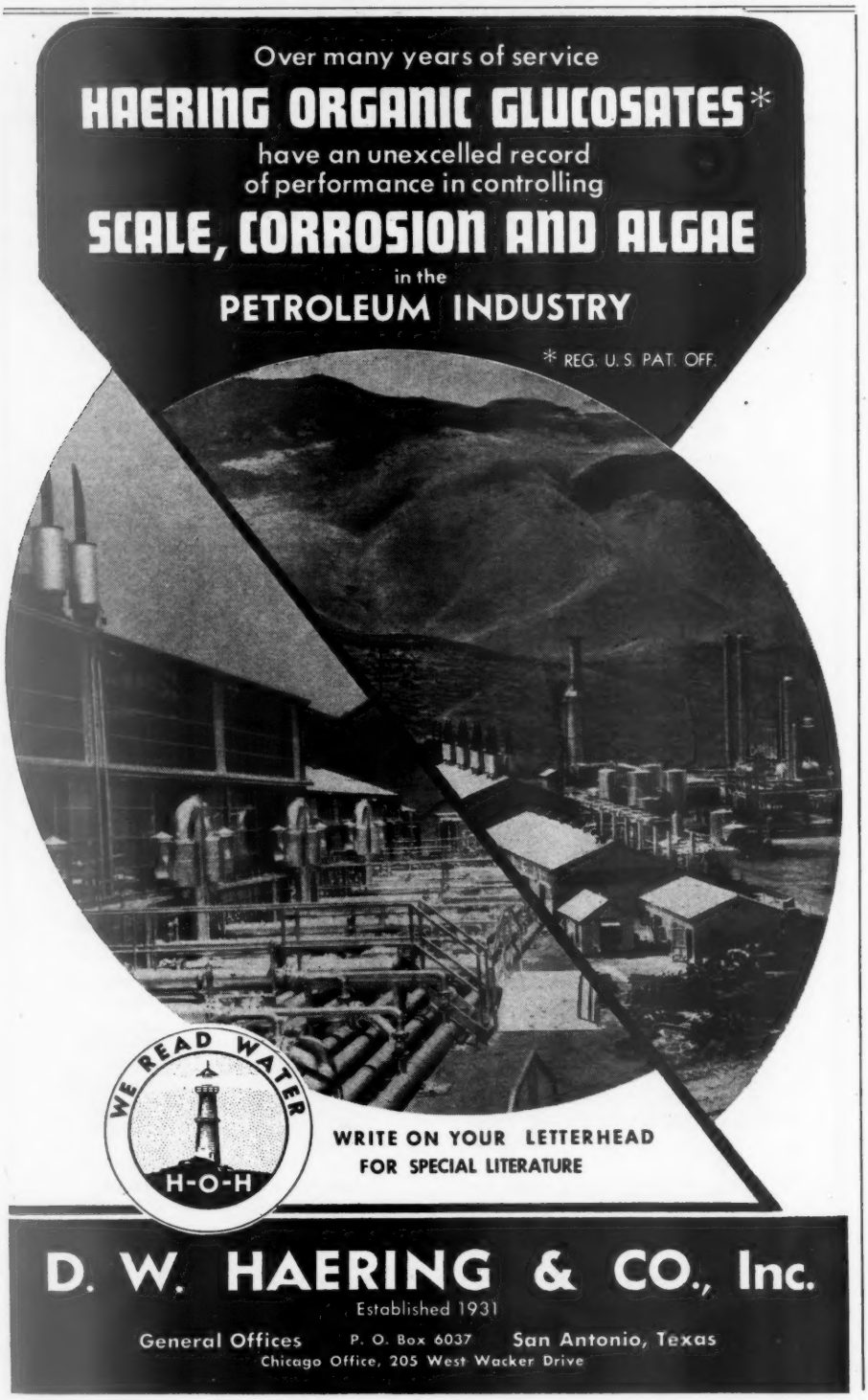
Acme Fishing Tool Company, Parkersburg, West Virginia, has announced development of its new type "Drilmor" alloy bit, which the manufacturer states is capable of cutting through hardest formations. Acme states that the alloy bit can be dressed and properly tempered in the field and without special equipment, in the same manner as a "regular".

(13) Bit Attachment

Ingersoll-Rand Company, 11 Broadway, New York, New York, has announced development of a new attachment for tungsten carbide bits. The attachment is of the shoulder type employing a patented 38-deg reverse-



buttress thread. It was developed to resist shock and impact as well as slippage, excessive thread wear, or loss of drilling speed. According to the company, the threads on the attachment are designed to last for the life of the bit. Four sizes of attachments are offered to cover bit gauge sizes from 1⅜ in. Additional information may be obtained by writing the company.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(14) Slush Pump Parts

Distribution is being made by The National Supply Company of its new Bulletin 357-A (which supersedes Bulletin No. 357), describing and illustrating Ideal fluid end parts for slush pumps. The 16-page bulletin includes pictures and descriptions of Type "G" valves and seats, which have been developed by pump designers to give maximum pump efficiency.

This fluid valve is now equipped with extremely tough, oil, gas, heat and chemical resistant, all-purpose "Blue Dot" discs for increased valve life. Other parts are described and pictured as to features and advantages of each part, together with instructions how to install and get maximum service from parts. Copies of Bulletin 357-A may be obtained by writing the company at P.O. Box 899A, Toledo, Ohio.

(15) Diesel Engines

Complete specifications for automotive and industrial models of two V-type, 12-cylinder Cummins diesels, the 550 hp (maximum) NVHS engine and the 400 hp (maximum) NVH engine, are contained in two bulletins just announced by the Cummins Engine Company, Inc., Columbus, Indiana.

The bulletins contain installation drawings, photographs, and charts on torque, horsepower, and fuel consumption, in addition to general specifications for standard equipment. Bulletin No. 5295 (NVHS-1200) and Bulletin No. 5294 (NVH-1200) may be obtained from Cummins dealers or by writing the company.

(16) Alloys

A new edition of the 40-page booklet "Hastelloy High-Strength, Nickel-Base, Corrosion-Resistant Alloys" has just been published by Haynes Stellite Division, Union Carbide and Carbon Corporation, Kokomo, Indiana. It tells the complete story of the four Hastelloy alloys—what they are, how they can be fabricated, and also how they can be used to combat severe corrosion.

Several pages in the booklet are devoted to descriptions and suggested uses of the various forms of the Hastelloy alloys—conventional and precision castings; hot-rolled bar stock, sheet, and plate; wire, tubing, and welding rod; also pipe and pipe fittings. Proper procedures for the welding, heat-treating, hot-working, cold-working, surface preparation, machining, and grinding of the alloys are also given.

(17) Air-Entraining Cement

Just published by Universal Atlas Cement Company is a 20-page, two-color, commemorative booklet entitled, "A Decade of Atlas Duraplastic." It traces the 1939-1949 period of the origin, development, and use-acceptance by the construction industry of Duraplastic air-entraining cement.

With deliberate restraint on technical details and with accent on pictorial-testimonial presentation, the booklet describes how Duraplastic was developed originally. More than 50 typical installations made during the past decade are illustrated and captioned describing Atlas Duraplastic air-entraining cement.

Copies are available from the company, 723 Chrysler Building, New York 17, New York.

(18) Slush Pump

Emsco Derrick and Equipment Company, has announced publication of its new 4-page pamphlet featuring its new D-850 duplex power slush pump. This newest addition to the Emsco line is claimed by the manufacturer to be the world's largest duplex power slush pump, yet it weighs slightly less than 53 lb per input horsepower.

The bulletin describes the Emsco pump in detail and is available from either the Houston, Texas, or Los Angeles, California plants of Emsco Derrick.

(19) Shaft Data

A new 20-page bulletin on shaft data is now available from De Laval Steam Turbine Company, Trenton 2, New Jersey.

The bulletin contains formulae, curves, and tables that will materially assist designers in determining proportions, stresses, combined torsional, and bending loads, etc. in round, square, hollow, keyway, and stepped shafts. This data was originally compiled for use by De Laval engineers.

(20) Water Softeners

A bulletin on the most recent developments in hot-process water softeners is now available from Graver Water Conditioning Company, 216 West 14th Street, New York 11, New York, division of Graver Tank & Manufacturing Company, Inc., which has specialized in the field of water conditioning for more than 40 years.

An introductory section of the bulletin explains the boiler plant troubles caused by various impurities in water, and outlines 12 different methods of treating water to eliminate them.

(21) 1949 Review

The 1949 annual review of engineering developments at Allis-Chalmers Manufacturing Company, Box 512, Milwaukee, Wisconsin has been published in a 40-page booklet.

Divided into 12 sections, the bulletin gives developments made in each of these sections by Allis Chalmers. Sections discussed are power generation, power distribution, public works, metals, coal, rock products, petroleum, forest products, etc.

(22) Trenchliner

Parsons Company of Newton, Iowa, has published a new catalog describing the latest improvements and capacities of the Parsons Model 250 Trenchliner. Printed in attractive colors, the 8-page bulletin contains photographs depicting many exclusive Trenchliner features along with schematic drawings listing the detailed di-

mensions of the machine. Parsons is a subsidiary of the Koehring Company of Milwaukee, Wisconsin.

Some of the exclusive features described in the catalog are: The arch type frame for maximum strength, low overhead clearance and improved digging balance; the shiftable boom that permits off-center digging within 1¼ in. of outside edge of either crawler; the reversible conveyor that shifts by power to either extreme side of the machine in less than one minute.

(23) Regulating Valves

Many types of regulating valves for water, steam, air, gas, or oil are presented in Bulletin No. 10-1, offered by the Minneapolis-Honeywell Regulator Co., Belfield Valve Division, Philadelphia, Pennsylvania.

Included, with descriptive photographs and schematic diagrams, are the quick opening regulating valves, iron body bronze mounted or all bronze; semi-balanced regulating valve; rotary shaft regulating valves and float or tank valves. Also, a page is devoted to pressure regulator and reducing valve disc-plugs.

Complete dimension charts are given for the various types or regulating and float values. Bulletin may be obtained by writing the company.

(24) Heat Exchangers

Standards of Tubular Exchanger Manufacturers Association, 1949 Edition, a 94-page, wire-o-bound book, has just been published by the Association, a group of eleven leading manufacturers of shell and tube heat exchangers.

Of value to anyone concerned with the design, manufacture, specification, purchase, operation or maintenance of tubular exchangers, this volume covers such subjects as: Fabrication and performance; mechanical standards for petroleum refineries, commercial and general process applications; material specifications; fouling factors, temperature and temperature differences; heat transfer and pressure drop data; thermal properties of fluids; installation, operation and maintenance; characteristics of tubing.

Copies of the book are obtainable at the Association's actual cost of $3.00 for paper cover editions and $4.00 for fabrikoid cover editions by writing George P. Byrne, Jr., secretary-treasurer, Tubular Exchanger Manufacturers Association, Inc., 53 Park Place, New York 7, New York.

(25) Levelimeter Instruments

A new 24-page catalog describing Fischer and Porter Company's line of Levelimeter instruments has just been published. These instruments indicate, measure, and control liquid level and inter-face level. Variations in liquid level in weirs and flumes are utilized for measurement and control of large flow rates.

Illustrated and described are magnetic tape-and-drum, electronically transmitting, ball-float, pneumatic and differential pressure units; V-notch weir and Parshall flume flowmeter instruments; and chemical service sight gauge glasses.

Copies of catalog section 75 may be obtained by writing to the Fischer & Porter Company, 75 County Line Road, Hatboro, Pennsylvania.

(26) Red Mud Conditioner

Baroid Sales Division, National Lead Company, Los Angeles 12, California, has published a bulletin descriptive of "Tannex Red Mud Conditioner No. 11"—a new Baroid product. It provides a safe, convenient method of making up a "red mud" at the well, or of conditioning a "red mud" already in use.

It is an alkaline tannate solution, each gallon of which contains 4 lb of caustic soda and 4 lb of quebracho compound "Tannex." It is sold in steel drums containing 650 lb, which can be stored outside for instant use.

The use of this product saves the time and labor incident to mixing the dry ingredients at the well and eliminates the hazard connected with handling and mixing flake caustic soda.

Copies of the bulletin may be obtained from the Baroid division of National Lead Company.

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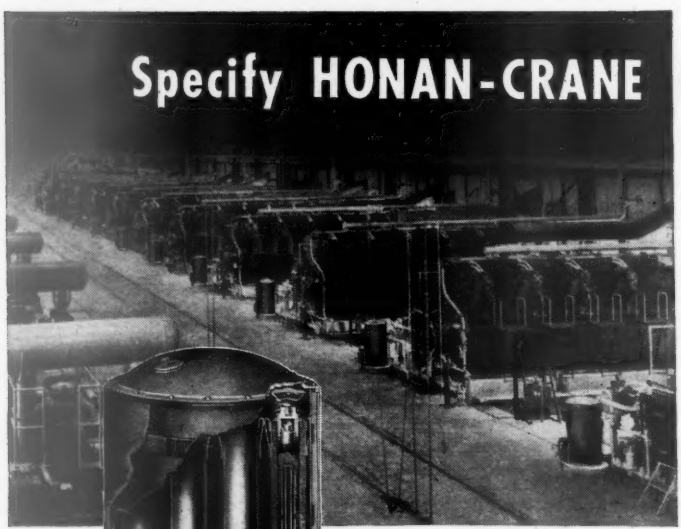

In this plant Honan-Crane Purifiers are direct connected to twenty-four 1,000 HP Cooper-Bessemers; nineteen 1,000 HP Worthingtons and eleven 1,450 Rathburn Jones engines... a total of 68,950 HP.

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On-the-job performance has proved that the *best* saves you *most* in the long run. Give your diesels the finest protection you can buy . . . specify HONAN-CRANE.

For complete information (or, a Honan-Crane resident engineer will call at your request) . . . write to Honan-Crane, 573 Wabash Avenue, Lebanon, Ind.

HONAN-CRANE CORP., Lebanon, Indiana

Subsidiary of HOUDAILLE-HERSHEY CORP.

(27) Calibrating Tanks

The Warner Lewis Company, Box 3096, Tulsa, Oklahoma, has issued its latest meter calibrating tank bulletin, No. CT 101-50. The bulletin shows a number of tanks that have not been pictured or described before. Included is a description of the Excel-So 50-gal "Squatty" tank recommended for 35 and 50-gal truck meters, and also available in 84, 100, and 150-gal capacities with low silhouettes. Models range from 50 to 2000 gal and 2-5-10-15-20 and 30 bbl, in either stationary, or portable with or without springs, open or closed type necks, and with electric or pneumatic brakes. All designs are in accordance with API Code No. 1101 recommendations except for modifications according to individual customer requirements.

(28) Natural Gas Control

A new catalog, "TAG Fully-Automatic Control for Saturation Control of Natural Gas," has been published by the Weston Electrical Instrument Corporation, of 614 Frelinghuysen Avenue, Newark 5, New Jersey.

The TAG saturation controller is a recording and controlling instrument that operates on the psychrometric wet- and dry-bulb principle. It automatically regulates and maintains the wet-bulb (relative humidity) depression for which it is set, regardless of variations in the dry-bulb gas temperature. The new literature, designated Catalog No. 1287, is of especial interest to utility companies that are planning to make, or have made the conversion from manufactured to natural gas.

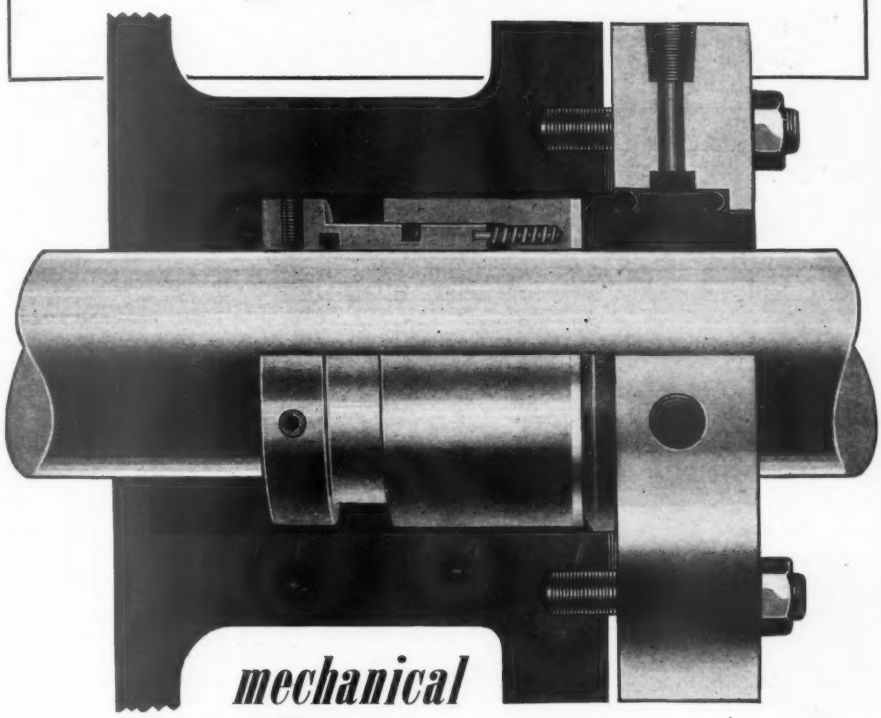
(29) Castings

The Ohio Steel Foundry Company, Springfield, Ohio, has published a 4-page bulletin on Fahrite corrosion resistant castings. The various types of castings of different grades to meet exacting chemical requirements and engineering specifications are pictured in the bulletin. Also included is a table of specifications for Fahrite castings.

(30) Drilling Rig

An interim bulletin, 12 pages, describes National Supply Company's new Ideal Type T-16 consolidated rig designed for shallow drilling and workover jobs and has a rating of 160 hp. The bulletin features compactness and portability of the rig, design details comparable to larger rigs, flexibility of use, and gives specifications, engine performance charts, and drawings with dimensions and shaft speeds. Copies are available from National Supply, Box 899A, Toledo, Ohio.

A New Achievement In High Pressure Sealing for Light Hydrocarbons



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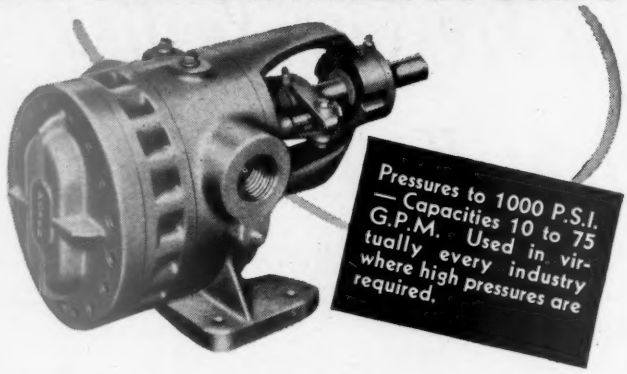

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Industrial Chemistry: 5th Edition. *E. Raymond Riegel, Reinhold Publishing Corporation, 330 West 42nd Street, New York. Pages, 1014. Price, $7.*

Designated in its title page as "An elementary treatise for the Student and General Reader", this compendium of information covers practically every possible phase of chemical production. Toward the back of the book are six chapters devoted to chemical engineering appliances, instruments, construction materials, etc. of wide interest to the industry and its chemists and engineers. The 50 chapters of the book are systematized to cover inorganic and organic fields, with considerable attention to plastics and synthetic resins, rubber, insecticides, metals, dyes, fats and oils, etc. Two chapters, one on the petroleum industry and one on synthetic and semi-synthetic organic chemicals, will be of primary interest to the petroleum chemist and engineer, the petrochemical fraternity will find much more in the volume of direct interest and usefulness to them.

The Economics of Industrial Management, *by Walter Rautenstrauch and Raymond Villers, Funk and Wagnalls Company, New York, in association with Modern Industry Magazine, New York. Pages, 451. Price, $5.*

This book describes in detail the latest developments of the Break-Even Chart process of analysis, invented by Rautenstrauch several years ago, and gives a full explanation of its practical application. It gives the fundamental principles involved in a study of industrial costs—principles of costs classification, and of costs allocation. With a view to practical use in all situations, the book applies the science of industrial economics to industrial engineering and accounting.

Manual of Spectroscopy, *Theodore A. Cutting, Chemical Publishing Company, Brooklyn, New York. Pages, 220. Price, $6.50.*

One of the most useful parts of this new book on this increasingly interesting and important subject is the careful treatment of the subject of "Characteristic Lines of The Elements", which occupies Chapter 6 and the greater portion of the book. A close second to this is Chapter 7 giving the wave-length Table-Chart of elements and materials. Little attention is given to organic compounds or hydrocarbons, the entire book, practically, dealing with the elements and their identification. A list of firms selling spectrographic equipment is included, which may be of considerable use to technologists and laboratories interested in this field.

Weld Design, *by Harry D. Churchill and John B. Austin, Prentice Hall, Inc., 70 Fifth Avenue, New York 11, New York. Pages, 216. Price, $6.50.*

The authors have attempted to write a concise volume on welded machine-base design, approaching the subject from both the theoretical and practical standpoints. Included in the book are numerous applications of weld-design principles fully detailed. Complete information is given on how to specify a weld as to requirements of both strength and economy. Types of welded joints, their characteristics, applications, and their drawing symbols are fully explained. Information is presented on how to specify for welding: Materials, materials preparation, electrodes and procedures. One complete chapter is devoted to explaining how to figure costs.